UNIV.

Engineering News-Record

Devoted to Civil Engineering and Contracting
McGraw-Hill Company, Inc.

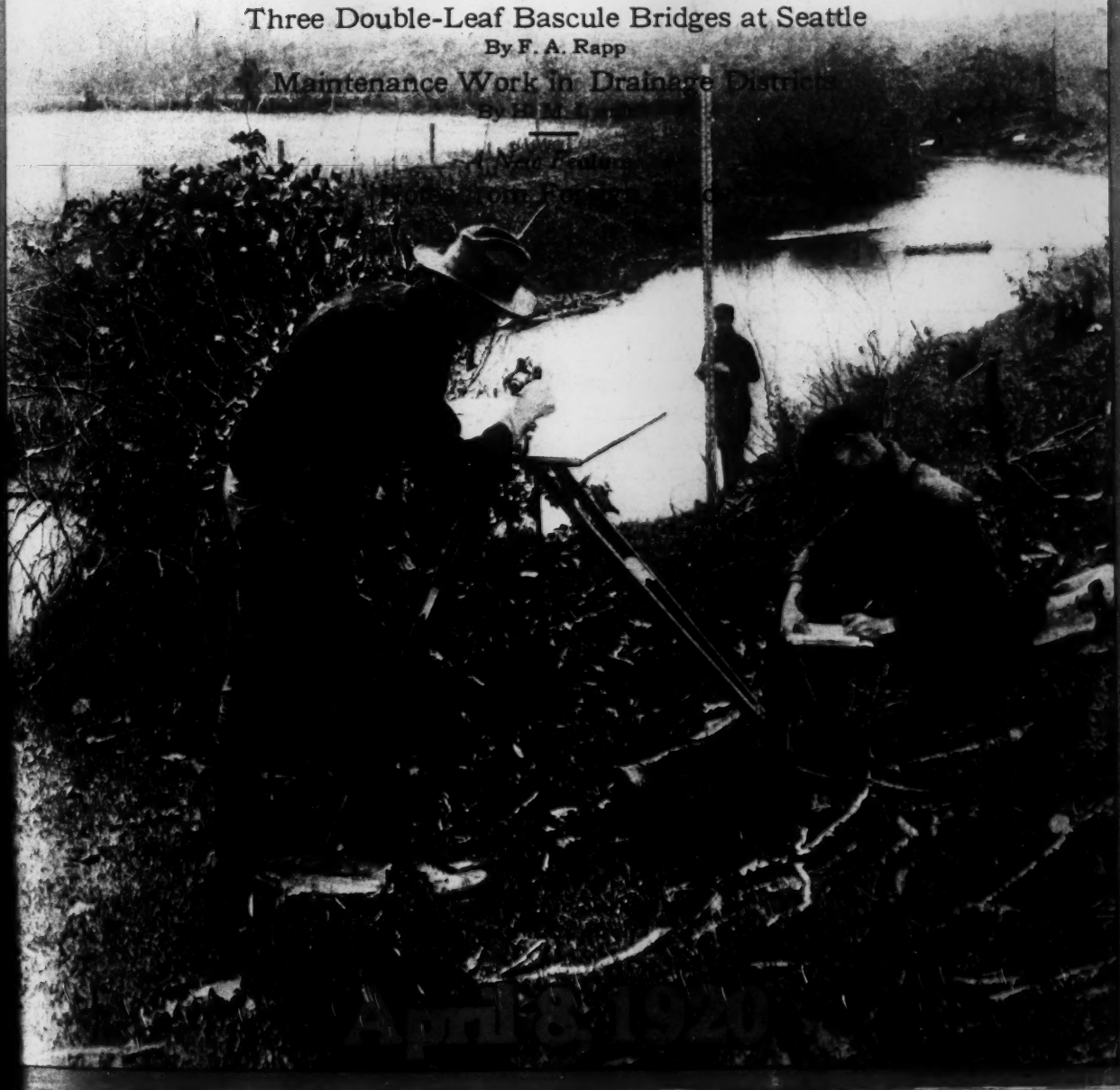
In This Issue:

Topographic Survey of City of Flint, Mich.
By C. S. Elicker

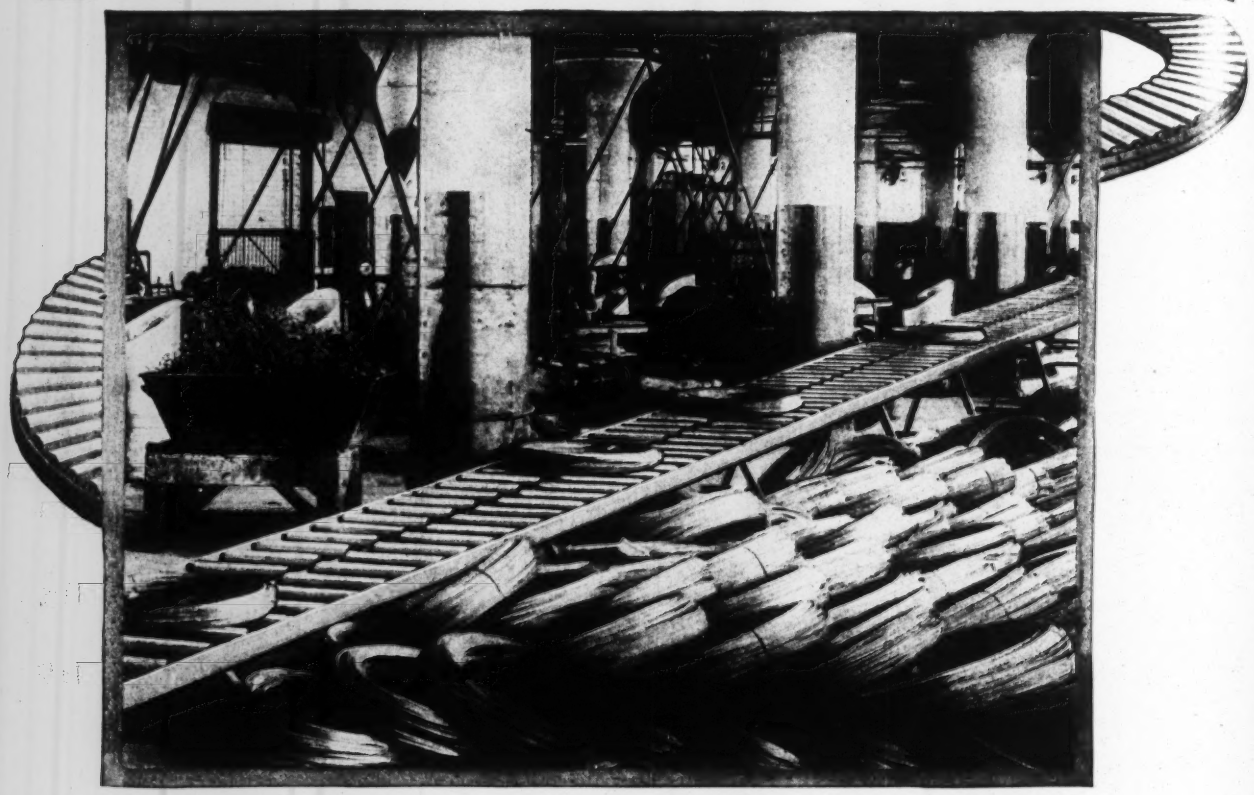
Three Double-Leaf Bascule Bridges at Seattle
By F. A. Rapp

Maintenance Work in Drainage Districts
By H. M. [illegible]

[illegible]



April 8 1920



EVERY pair of hands and legs you relieve from lugging, wheeling or hauling things from place to place immediately becomes available for more productive work.

And when you do that costs start to drop, output increases, overhead takes a favorable turn—downward.

The Mathews steel ball-bearing roller Conveyer not only takes the place of human labor, but it entails no expense for power. *Gravity* operates it!

Utility: The Mathews can be adapted to practically any manufacturing business, plant or yard layout; to carry heavy or light work—over, under or around obstacles, or straightaway. Portable or permanent installation. No upkeep worth mentioning; doesn't go on strikes; demands no pay envelope; creates no power bills!

Our engineers' suggestions as to how and where the Mathews can be made profitable to *you* cost nothing. Write.

Mathews Gravity Carrier Co.
118 Tenth Street, Ellwood City, Pa.

Branch Factories:
Port Hope, Ontario London, England

MATHEWS
SPEED ECONOMY
GRAVITY ROLLER CONVEYER

A Consolidation of Engineering News and Engineering Record — McGraw-Hill Company, Inc.—JAMES H. McGRAW, President

ENGINEERING NEWS-RECORD

DEVOTED TO CIVIL ENGINEERING AND CONTRACTING

E. J. MEHREN, Editor

Volume 84 — NEW YORK, THURSDAY, APRIL 8, 1920 — Number 15

Local Legislation on Housing

WE INTIMATED last week, in an editorial advocating the budgeting of construction, that, unless construction industries voluntarily took steps to prevent senseless bidding for labor and materials, there might be compulsory restriction. An indication that this was not unfounded surmise is shown by the passage by the New York State Legislature last week of twelve bills, not, it is true, to regulate construction, but to prevent profiteering by landlords and the imposition by them, through radical rent raises, of hardships upon the community. Several cities in New Jersey have under consideration similar measures. It is but a short step from regulation of existing housing facilities to the regulation of prospective housing. Moreover, any one who gives fair consideration to the seriousness of the housing situation must admit that it has got beyond a matter for purely private consideration and is properly a subject of public concern. The State, whether it will it or not, is forced by its duty to take steps to protect the public. We may fume as much as we wish against public interference, but public interference at times is a public dutv.

Incompetence and New York's Port

IT HAS frequently been said that the City of New York has no port policy. In general that is true. The succeeding administrations, of opposing political faiths and varying practices, start afresh every four years on schemes of their own making. Thus we have planned a pier here, a group of piers there, a magnificent dream of a Jamaica Bay one year and some ineffective and unconnected piersheds at Staten Island some years later —all designed and built with a view to the immediate return, political or financial. One idea, however, has been tenaciously held through all other changes: foot by foot additional pier and slip space must be gained from the fairway of the Hudson River. The process has been going on for many years, with a persistence worthy of a better cause. Re-entrant angles are cut off with the claim that no channel damage can be possibly done, and a few years later the angles made by the new lines are in turn flattened out with further inroads into the usable channel. On the plea of imperative commercial necessity and with the absolute promise of early withdrawal, the Federal Government grants permits for temporary pier extensions, only to be met a few years later with demands that the permit be extended in scope and made permanent. There is no use wasting paper in denouncing this encroachment or in pointing out how shortsighted it is even for the city itself, which is only one of the interests concerned with the preservation of the lower Hudson as a waterway. But the revived demand for pier elongation does serve to show how incompetent are the city authorities, and the commercial influences behind them, to plan the future of this national asset, the Port of New York.

"Mistakes Year After Year"

CONCEALED among the illuminating statements of General Goethals on tunnel construction—to which we hope to come back at a later date—there is an incidental remark too interesting to ignore. He speaks of "the same mistakes that have been made year after year in engineering matters in dealing with the transportation of the public in Manhattan and vicinity in that the structures would be taxed to their capacity almost at once upon their completion and going into service." This is a plain charge of lack of foresight. It is impossible to avoid the sting of the charge, for all engineers familiar with New York conditions will concede its substantial truth. Nor is lack of foresight, or perhaps we should say breadth and clearness of vision, confined to transportation. As we have just remarked, the same lack appears in port development and other essential affairs of the country's metropolis. It is much open to question, of course, whether engineers or the public's legislative and political representatives were lacking in foresight. The latter must bear the chief blame, in our opinion. But though this may serve as excuse for the happenings of the past, when the engineering profession notoriously was without influence on public affairs, no such excuse can hold in future. In the more influential position in the world for which engineers are now striving, it will be their responsibility to prevent the continuance of lack of foresight such as that of which General Goethals complains.

Reducing the Black Area

NO BETTER index to the progress of public health and sanitation is afforded than vital statistics. So backward has the United States been in this matter that in tables compiled to show comparative vital statistics for the principal countries of the world the United States has been absent or else such figures as were given have been accompanied by footnotes explaining that they were incomplete. This has been largely due to the fact that each of our commonwealths is a law unto itself as regards vital statistics, with no central control of the matter by the Federal Government. Our Census Bureau serves merely as a compiler for the Government of the United States of such figures for the several states as are sufficiently reliable to be admitted into comparative data. The states and cities so admtted are known as registration and those not yet admitted as non-registraton states. One by one our commonwealths have come into the registration area. The progress has been quite rapid of late, but there still remain 15 states in solid black representing the non-registration area on the map shown on p. 732 of ths issue. Nine others are shown shaded on the map to indicate that death registration only has thus far been attained. In the white area or full registration states 24 states appear—greatly to their credit. The engineer is more directly concerned

with death than with birth registration statistics, but for some studies entered upon by sanitary engineers birth statistics are useful. Health officers cannot do their work properly without both. This is an off year for state legislatures. It is none too soon to lay effective plans for increasing the registration area of 1921. Doubtless some of the states need no further legislation to make it possibble for them to gain admission to the registration area. If birth and death registration cannot come together, death registration should come first.

Progress of the Co-operative System

IT IS gratifying to note that another important institution has adopted the co-operative principle in engineering education. Harvard announces that its junior year may henceforth be taken on the co-operative plan. The details differ from the method as applied by Dean Schneider at Cincinnati, notably in that the alternations are by two-month rather than by two-week periods. Gradually the Cincinnati plan is making headway—a progress that has the hearty approval of practitioners.

Stubborn Criticism

IT IS curious to note the stubbornness in some quarters of the criticism of the co-operative system of education. By some it is never discussed in moderation, but always with a certain savagery, as if the proponents of the co-operative plan had personally affronted those who adhere to the usual method. And then there are those who, impressed by the sound features of a co-operative relationship but not ready to introduce it, declare that the idea is applied in their schools because their students do practical work during vacations. The second group, particularly, arouses protest. The attempt to square their traditional policy with a new idea—to camouflage their unwillingness or inability to inaugurate a truly co-operative course, in part at least—deceives no one but themselves. To contend that the unsupervised, uncoordinated work of summer vacations produces the same results as the planned, coordinated industrial work of the co-operative course is evidence of either ignorance or mental blindness.

New York is Progressive

IN THE past the members of the American Society of Civil Engineers have rightfully held New York to be the center of society conservatism. The first clear indication that the majority in District 1 might no longer be ultra-conservative appeared at the Annual Meeting in January, but even then there was doubt. There was present the largest representation, numerically and proportionally, of non-resident members in recent society history; they were not alone sufficient to account for the overwhelming progressive vote, but how the New Yorkers divided was not definitely ascertained. Last week, though, there was an out and out test of sentiment—at the first regular meeting of the New York Section. There were only 100 present out of a section membership of 192 and a district membership of about 1,800. But the gathering seemed representative. There were the older men—the confessed and recognized conservatives—a goodly group of quite young men and a large number of men between the ages of 35 and 45. On a test vote the progressives won, while four out of the five members chosen for the section nominating committee are known to advocate a progressive regime. But the really significant indication followed a brief address by the president of the society, Arthur P. Davis. With no mincing words he criticised the past inactivity of the society, concluding with the statement that those who were responsible for that inactivity were the ones who today are opposing the expansion of the society's work, through a broadening of the Engineering Council idea along the lines proposed in the Joint Conference Committee's report. His conclusion was greeted with thunderous and long-continued applause. It was not courtesy applause, nor did it come from a strenuous minority. It was clearly a full endorsement by a large majority of the president's views. * * * * We had feared an adverse vote in District 1 on Question 3. We have less fear now. New York *is* progressive. The showing last week will put heart in those New Yorkers who have been indifferent to the society's activities because they had despaired of stirring the conservatives into action.

New York Section's Opportunity

THE New York section of the American Society of Civil Engineers has a remarkable opportunity. It will draw from the largest district in the society, containing about 1,800 members. Its dues are relatively high—five dollars a year. With a reasonable proportion of the eligible members joining, there will be revenue sufficient for a wide variety of activities. New York should become the leading section in the country, but it will realize its opportunity only if the management is progressive, if it have energy, if it will refuse to be tied by the conservative traditions of the past and will attract a large membership and energize it through a broad and active program. Happily, the meeting last week indicated that a majority can be mustered for a progressive management. That obtained, the New York section will not only do credit to itself, but will be of material benefit in setting an example for the society. On top of the ten dollars' extra dues paid to the society itself by so-called "resident" members, the imposition of another five dollars in dues for the New York section will require sacrifice on the part of many. But the sacrifice should be made willingly, for the returns, with a progressive management, will certainly justify the expenditure. Particularly will the fee cause some hesitancy on the part of the young men, and even of those in middle life, but these are just the men whose sacrifices and participation in the work of the New York section will make it really worth while.

Will Rivets Have to Go?

FOR quite a few years various men have dreamed of a transformed art of steel construction, in which there would be no rivet connections but, instead, some other means of joining parts, perhaps welding. No progress toward the realization of such dreams could be discerned until the period of the war, when shipbuilding called for the aid of welding. A committee of experts on such work, formed to aid shipbuilders, unfortunately produced few if any results. Hopes that the problem of making fusion-weld connections to carry definite stresses would be solved were disappointed. An independent attack on the problem, by practical trial, is now being made, as recorded in this issue. Under the circumstances the undertaking is invested with all the interest of pioneering, and the men back of the experi-

ment—for it must be regarded as such—are entitled to praise for their courage and faith. Many difficulties of a metallurgical and practical kind stand in the way of a wholly satisfactory rating of the welding process as concerns reliability of strength, and therefore service data need to be accumulated. Probably the most significant information on this point will come from ship service. In the shipyards fusion welding is already widely used for calking seams, and is being tried out on strength seams, such as those of the shell plating. Because of the many interrelated joints and the constant flux of stress under wave action, a ship's structure can give a much quicker and less hazardous proof test of the jointing method than could be obtained from a building frame or a bridge span. On the questions of economy and increased convenience of construction, however, such trials as that in the Brooklyn building can prove most valuable in outlining the field to which welding properly belongs.

New Labor Thinking

WHEN the American Federation of Labor some months ago issued its so-called "Bill of Rights," we called attention to the new economic note found in several paragraphs. The document, otherwise, was in typical Federation style. That we were right in taking these paragraphs as significant, is shown by the economic program outlined by Mr. Gompers in his statement of March 21. The chief features of the program were given in a news item in our last issue.

Apparently, the day of the loud mouth and the unused brain is to pass, and we are to see here something that will eventually approximate the leadership which has played an important part in English labor circles.

Undoubtedly we may lay this to the war. Gompers and some of his ablest lieutenants were in England during the war, while British labor leaders and labor delegations were here. Our men must have seen the inherently greater strength of the British position, and a broader program was to be expected.

Now we have the program—and it is not to be regarded lightly. Most of the proposals are old; the significance lies in the fact that labor has adopted them. Most of them have what we have been accustomed to describe as a "socialistic flavor." All but two, which aim to protect labor specifically, are socialistic in the general sense that they are aimed to redound to the common welfare as against that of any class. We will not all be in agreement with labor that the proposed measures will, without exception, be of benefit to the public, but the intent is evident.

Some of the proposals are of a nature to cause thoughtful people to do a deal of thinking. For example, while we experience somewhat of a shock at the proposal to supervise Federally the issuance of capital stock of all corporations, one need not have more than average intelligence to realize that such control has some justification. The stock-jobbing that has taken millions from the public and put them into the pockets of clever manipulators is decidedly unpopular. Skillful leadership can easily make corporation-stock control an issue that will attract country-wide attention and extensive support.

It will be more difficult to popularize the plank declaring that control of credit should be a public function, administered in the interest of the community instead of the bankers, but once it begins to sink in, it too can be made a strong and popular issue.

In some quarters there will be grave misgivings over the entry of labor on an economic program. How can labor be expected to think soundly on economics? Is there not certainty that the thinking will be wrong and misleading? Such will be the queries. Without a doubt there will be experiments in economic thought, there will be proposals subversive of what now passes without general challenge. But among intelligent people who are also fairminded we believe a broader thinking will be hailed as a step forward. Certainly the real leaders of the British labor party enjoy a general confidence not shared by labor here. A sounder grasp always makes for saner conclusions.

The Soviets at Work

UNDER the title, "The Soviets at Work," Lenin has recently made a statement that, like some of the statements quoted in Miss Kellor's article in our issue of March 11, should be brought to the attention of every American workingman. It deserves quotation in full:

"The Bolshevists have destroyed capitalism, nationalized industry and formed workers' soviets. But Russia is still far from communism and a socialistic Soviet republic.

"What the Bolshevists have done so far was the easiest part. It was the destructive part. It required only force and decrees. The hardest part is still before them. Bolshevism will fail unless it can rebuild Russian industries and get maximum production.

"This cannot be accomplished under the original plan of Bolshevism. The workers' soviets don't know how to run the factories and keep order. And the workers aren't yet willing to work for the same rate of pay for different kinds of work. The machine worker still wants more than the man with a pick; and the brain worker still wants more than the machine worker. Russia will not have communism until human nature is changed and each man is willing to work for the good of all instead of for personal gain.

"It will take years to change human nature by education and to teach workers to run factories by soviet methods. But in the meantime industry must be recognized and maximum output by both factory and the individual worker maintained.

"The only course before the Bolshevist leaders is to take a step backward from the Soviet state—to return to the old order. They must call in bourgeois experts at large salaries to run the factories. They must adopt the factory methods of capitalistic America.

"And the Bolshevist leaders must go back still further. They must place the workers under iron discipline. They must make the hundreds and thousands of workers in each factory subject to the will of one man—the bourgeois manager. The workers must be compelled to work their hardest."

Thinking men by the thousands have said that with an ideal human family socialism would be a most desirable system. Lenin, the proponent of Russia communism, from the depths of his terrible experience, approves those views. If we could get a knowledge of what is transpiring in Russia into the minds of our loose-thinking elements it would lead them to improve what we have rather than advocate the Russian system—and to court the inevitable Russian chaos.

Topographic Survey of the City of Flint, Michigan

Plane Table Progress 28 Acres per Day, Traverse Three Miles per Day—For Accuracy Test Profiles Plotted from Completed Maps Compared with Profile Made in Field—Area Sixty Square Miles

By C. S. Elicker
ngineer in Charge for R. H. Randall & Co.
Toledo, Ohio

A TOPOGRAPHIC survey of the city of Flint, Mich., has been undertaken on account of the rapid growth of the city, the population of which has been doubled during the past six years by its industrial developments. It has been impracticable to carry out municipal improvements to keep pace with this growth, so that extensive works are now necessary, and as a preliminary to the design of sewerage systems for outlying districts, which are being developed for industrial purposes and some of which extend beyond the city limits,

FIG. 1. PLANE TABLE PARTY ON TOPOGRAPHIC SURVEY

the city authorities decided to have made a topographic map, to be so complete as to form a basis for the planning of other public works. In the making of this topographical survey the average progress was three miles per day on the traverses and 28 acres per day of topography with the plane table. Trial test profiles formed the basis of the final acceptance of the maps which have been produced in three colors.

Ten years ago Flint was an unpretentious city with a population of about 39,000, but its population now is over 100,000 and the city is overflowing with the influx of people required by the growing industries. The spread of the city is being guided according to a well thought out plan, and to the city engineering department falls the execution of a major portion of this city planning. During 1919 about $950,000 was disbursed through this department, which employes 800 men and has only about 10 per cent of its construction work done by contract (see *Engineering News-Record*, March 13, 1919, p. 524). The 1919 program included 18 miles of sewers, 7½ miles of street paving, 15 miles of sidewalk paving, two new bridges, a new asphalt plant and extensive park improvements.

The city's boundaries are being pushed outward to accommodate its rapidly increasing population, a condition which necessitates a large amount of detailed planning, especially in the design of new sewers, interceptors, disposal works and river improvement. In all such municipal works the contour of the ground is a primary consideration, and for this reason modern practice demands a topographical map as a basis for all such planning. The topographic features in and around Flint are such that the selected scale of 1 in. to 200 ft. with a contour interval of one foot will give a map having the widest range of usefulness and providing effectively for street and boulevard layouts, preliminary grading schedules, park developments and sewerage and drainage plans.

The present area of the city will soon be increased to include 30 sq.mi., while the expected area for 1960, as used in planning the sewerage system, is considerably greater. Sewer designing is a drainage area proposition and should not be limited by any established boundaries of a city. It follows that information must be obtained on the drainage above the area to be served. In a few cases, therefore, the mapping will be extended beyond beyond the expected 1960 city limits, so that the area finally to be mapped will approximate 60 sq.mi.

Prior to any field work this area was divided into sections one mile in length and three-quarters of a mile in width to conform to the standard plane table sheet. Upon this layout the traverse and level control were planned to adequately control each section.

Due to the slight amount of relief and the fact that this survey is for the sole purpose of constructing a topographic map, primary traverse of a high order is sufficient for the horizontal control. Accurately measured traverse lines are run over the principal streets and highways to form a network of base lines. Measures of direction are made to 30 sec. of arc and measures of distance to hundredths of a foot.

Points are set and their positions witnessed at intervals averaging 1,000 ft. along the line traversed. The usual length of traversed line for one day with a party of four was three miles. The traverse circuits are computed by latitudes and departures, and the delicate adjustments made according to the varying conditions that govern. From these figures the rectangular coordinate distances for each point in the traverse net are computed.

Representative traverse circuits are shown in Table I, in which the circuit closures represent the work done by an experienced party, using no unusual methods of refinement and progressing at the rate of three miles per day. Traversing is done with a 100-ft. steel

tape. Where the slope is more than two feet in a chain length the tape is held horizontal and a plumb bob is used to locate the point. Sights do not exceed 2,500 ft. and are made on the ordinary sighting rod and the edge of a stadia board. Angles are read with an instrument graduated to 80 sec. of arc.

The vertical control is supplied from permanent, precise bench marks that were set prior to this survey and referred to mean sea level datum. As these cover only a small part of the area to be surveyed, level lines are run to the outlying areas and temporary bench marks established. Such precautions are taken as are necessary to obtain a closing error within the limits of $0.05\sqrt{M}$, in which M is the distance between bench marks.

TABLE I. REPRESENTATIVE TRAVERSE CIRCUITS ON THE SURVEY AT FLINT, MICH.

Distance Around Circuit, Feet	Error in Latitude	Error in Departure	Error of Closure
31,717.83	1.44	2.64	1:10,550
23,682.10	0.93	0.40	1:23,400
44,695.95	0.84	0.95	1:35,025
29,104.60	0.45	1.48	1:18,825
11,837.20	0.51	0.01	1:23,175
27,478.24	0.85	0.07	1:32,225
27,478.24	0.85	0.07	1:32,225
36,211.05	0.57	1.72	1:19,975
17,260.00	0.14	0.51	1:32,625
16,110.70	0.18	0.62	1:24,950
11,915.35	0.88	0.59	1:20,625
Average			1:24,150

All mapping is done in the field by the plane table method.

Before any map sheets are taken into the field they have the traverse control plotted and the stations numbered in the office. The topographer is supplied with descriptions of all the traverse stations and bench marks in the section to which he is assigned. A plane table party consists of a topographer, a recorder and one or more rodmen. The rod used is constructed by tacking a flexible rod face, divided into tenths and hundredths of a foot, to a light board 12 ft. long. Fig. 1 shows the equipment of a party at work.

The secondary control for mapping is the graphic traverse run by plane table, stadia and magnetic needle, except where local attraction occurs. In such instances the needle is useless and orientation by backsights is the only alternative. Distances are read by stadia to the nearest foot and odd readings are made to the nearest tenth of a foot on side shots. In the extension of the controlling traverse, elevations are determined to hundredths of a foot. The recorder makes a record of all readings and immediately computes the plotting distance and elevation.

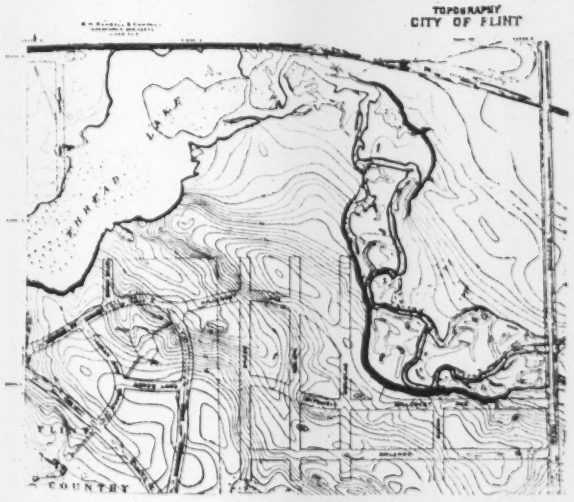


FIG. 2. PORTION OF TYPICAL SHEET OF TOPOGRAPHICAL MAP OF FLINT, MICH.

All streets and highways, public and semi-public buildings, electric and steam railroads are accurately located in addition to the land features. As the contours are sketched by the topographer while he is upon the ground the field map is as complete at any time as the existing information will permit.

Flint is located upon a small river and its topography varies from drift plains to rapidly undulating glacial deposits and a rugged river valley. The topography shown in Fig. 2 is representative of the area mapped to date. This cut is from a photograph of an original 24 x 30 in. sheet with 19.8 x 26.4 in. inside dimensions. An average day's work of mapping topography of this nature amounted to 28 acres.

To control the sketch of an acre of topography an average of 123 ft. of plane table traverse and ten locations was used. The average length of sight on this traverse was 400 ft. The closing errors in elevation averaged 0.04 ft., and the error of position easily falls within the maximum allowable of two feet for the first 1,000 ft. traversed and one foot for each additional thousand feet.

TOPOGRAPHIC SURVEY

Weekly Field Report by Days

Week Ending October 25, 1919

Party: Reading, Topographer; Srygley, Recorder; Glenn, Rodman

Job: City of Flint; Scale: 1" = 200'; Interval: One foot

	Weather	No. Hrs. in Field	Set Ups	Stadia Readings	Acres	Unit Cost	Sheet	Progress sq. mi.	Area of Sheet sq. mi.
Monday	Fair	8	7	400	60		17		006
Tuesday	"	8	4	500	40		"		
Wednesday	"	8	4	540	25		"		
Thursday	"	8¼	6	435	39		"		
Friday	"	8	3	515	29		"		
Saturday	Cloudy-Rain	4	2	230	27		"		034
Totals for Week	Excellent	44¼	26	2620	220		17	034	040

Remarks: Worked S.E. corner of sheet Thursday; 30 minutes rain Saturday; shots per acre high due to considerable detail in creek bottom.

FIG. 3. FORM OF REPORT OF SURVEY PARTY

The recorder of each party keeps a daily record of the hours worked in the field, the number of set-ups, the number of stadia readings and the acres mapped. These daily records are assembled into a weekly report similar to that shown in Fig. 3, the size of sheet being 6 x 4 in.

Before any drafting in ink is done, the sheet is subjected to a careful verification of block dimensions and street widths placed on the field sheet by comparison with the dimensions shown on the original recorded plats. Any material difference is decided by a second observation on the ground.

For purposes of legibility each class of cartographic features is shown by a special color. The surface relief is done in brown, the culture and lettering in black and the hydrography in blue. After all lines have been traced in their proper colors and suitable lettering supplied, the sheet is thoroughly inspected for any errors of interpretation that may have occured during the process of inking.

The survey has not progressed sufficiently as yet to permit of the reproduction of any map sheets. However, as soon as the original sheets are completed, reproduction in quantity will follow. This is to be effected by engraving the hypsographic, hydrographic and cultural features upon separate plates of stone or metal. From these plates prints are made in three colors. This method provides a copy fully as accurate and intelligible as the original and easier to work from. Such reproductions of the original secure for the maps a wider field of usefulness and provide against possible loss of any part of the survey.

After every precaution is exercised to insure a map that is as accurate as the scale will permit, no measure of its accuracy can be obtained other than by trial. This is best done by test profiles. A satisfactory result by this method is the condition to the acceptance of any field sheet as complete. The resultant profile of such a test for accuracy, applied to the sheet reproduced in Fig. 2, is shown in Fig. 4, together with a portion of the sheet over which the profile was run.

The profile was obtained by running plane table stadia traverse by magnetic needle orientation, starting from and closing upon the primary traverse as a base. Rod readings were taken at every change of grade along the line of sight, and at every opportunity, turning points that were set in the operation of mapping were made a part of the profile circuit. The circuit, 6,423 ft. in length, was plotted to a scale of one inch to 200 feet. The closing error of position measured less than three feet. Elevations carried throughout the circuit by level, top and bottom thread and angle readings showed an error of 0.17 ft. in closing.

After carefully adjusting these errors among the points of the circuit the probable error of any one point was easily less than the accuracy required for test purposes. The test profile was transferred to correct position upon the topographic map sheet and a second profile secured from the contour crossings. With the two profiles superimposed upon a large scale of one inch to 100 feet horizontal and one inch to four feet vertical there was an excellent opportunity for study and comparison. The areas of the sections formed by the crossing and recrossing of the contour profile over the test profile give a measurement of the topographer's sketching consistency and the accuracy of the resulting map.

TABLE II. ACCURACY OF TOPOGRAPHIC SURVEYS
(Comparative study based upon test profiles)

	Dayton	Jackson	Flint
Length of test profile	3,162 feet	3,150 feet	6,423 feet
Number of test points	50	52	130
Extreme relief	51 feet	38 feet	30 feet
Total plus areas	591 sq. ft.	1,048 sq. ft.	896 sq. ft.
Total minus areas	1,002 sq. ft.	628 sq. ft.	792 sq. ft.
Average uncompensated area	0.134 sq. ft.	0.188 sq. ft.	0.016 sq. ft.
Average error of each test point	0.55 feet	0.53 feet	0.26 feet
Test points that disagree with contours: By more than 0.5 feet	35%	37%	22%
By more than 1.0 foot	15%	11%	0.04%
By more than 1.5 feet	7%	4%	None

NOTE.—Scale of map in each of the above surveys is 1 in 2,400, with a contour frequency of one foot. The results for the Dayton and Jackson surveys are obtained from a number of tests. Only one test profile on the Flint survey was available when this table was prepared.

In the topographical maps accompanying this article it has been impossible, because of space limitations, to reproduce the full sheets. Enough is given, however, to indicate the general character of the Flint maps.

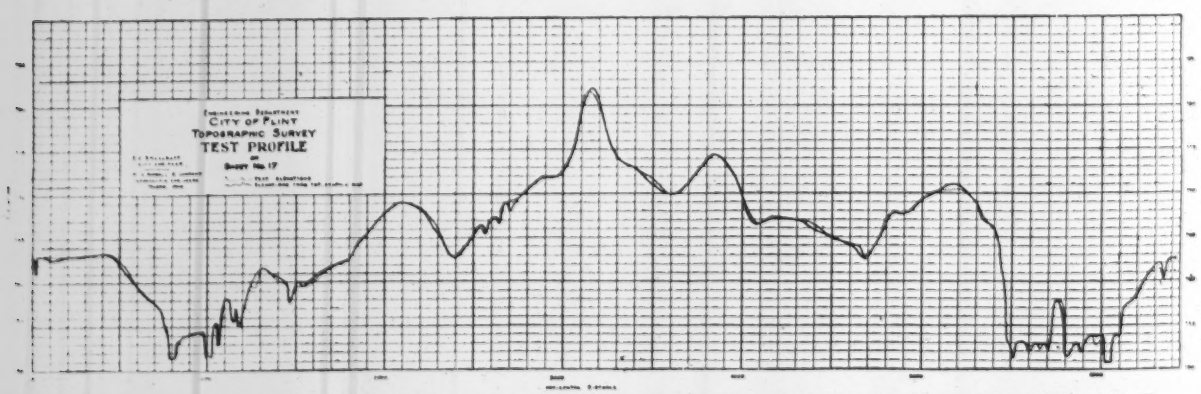


FIG. 4. TEST PROFILE FROM LEVELS SHOWS CLOSE AGREEMENT WITH PROFILE PLOTTED FROM MAP

How Lower Highway Building Costs?

By R. G. Collins, Jr.
Contracting Engineer, Baltimore, Md.

THE construction of highways with the greatest speed possible is admittedly an economic necessity. In view of the enormous mileage required in the United States and the great expenditure involved, consideration should be given to any possibility of lowering the cost of construction. Under the present abnormal conditions there is no excuse for failure, on the part of those charged by the public with the business of building these highways, to take advantage of every means of lowering the cost of construction and minimizing prevailing abnormal increases.

The reasons for the increased prices now being bid by contractors for highway construction are not at all hard to find; they are simply the result of the present system of contracts, which saddles upon the contractor the cost of every uncertainty which may arise though few of them are within his control or power to measure. He is merely waking up to the possibilities and trying to protect himself against not only loss of compensation for his own time and investment, but actual loss of money as well.

I believe that a study of the factors which go to make up a contractor's cost will show not only that he is not making unreasonable bids, but that it is comparatively simple to eliminate much of the uncertainty against which he bids, thus directly lowering the cost to the public of building the highways. The factors referred to are:

(1), Cost of materials; (2), payroll expense in actually supervising and performing the work; (3), investment in machinery; (4), expense of moving machinery to the site of the work and from it; (5), expense in maintaining machinery; (6), charging off a certain amount each year to pay for its depreciation; (7), cost of bond, compensation and public insurance; (8), loss of small tools; (9), supplies such as coal, gasoline, oil, etc.; (10), securing, maintaining and housing labor; (11), cost of sidings, trestle and temporary buildings or sheds; (12), general expense; (13), main office expenses; (14), interest on money required to operate the contract. These items are all tangible and can be measured with a considerable degree of accuracy when the contractor makes up his bid. He can also, to a great degree, control the expenditure under each head during the life of the contract.

Then comes the question, as to how much time he will lose between the time of finishing one contract and securing and starting another, during which he must carry his plant charges and a large portion of his specially trained organization. It is not merely the interest charge, etc., which is involved but the fact that his plant is not producing during this lost time. He really has no assurance that, having made an investment of thousands of dollars in machinery for a contract, he will ever get another contract.

Long-Life Contracts Needed

But if a contractor can see two to three years' work ahead of him in one section of a state, he can bid very much lower than if he has but one year's work in prospect and if, in addition, he does not have to take the gamble on increases in freight rates and costs of materials. If the state lets 1-yr. contracts it has to pay for these rises anyway and if it saddles them on the contractor to get the obvious advantages of letting work in 2- or 3-year sections it must and should pay them; and as no one knows what they may amount to it must pay enough so that the contractor will be safe no matter what they amount to when they come.

Therefore, if the public wants to lower the cost of highway construction to a degree that in a 3-yr. program will be almost unbelievable, let the contracts wherever possible in such amounts that a contracting organization will have from two to three years' work assured. There will always be enough contracts of necessarily small sizes to furnish work for the smaller contractors. Have the contractor, when he is awarded the contract, furnish a schedule of material and freight rates, on which he is basing his bids, the state checking these to see that they are really the market prices at the time, and then have the state stand any increases in such costs and get the benefit of any reductions—the contractor buying his materials, but the state to have access to invoices when a change in cost occurs.

Before allowing a contractor to bid on such sections, he should be required to show his experience in highway building, his financial backing, and his equipment on hand or just where he can secure such equipment promptly. This is necesary before he can be called "responsible," as required by law. In fairness to the contractor, the test should be applied before he goes to the trouble and expense of bidding, not afterward.

Do not let a contract to a contractor who qualifies as above, if his bid be *too* low, even though he may be able to secure a bond, because the public will pay in the end when a contractor has a losing job. In determining whether a bid is too low, the average of the bids received is almost always a fair measure of what the work is worth, with profit to the contractor, and a bid more than 10 per cent under this average is pretty sure to be below the actual cost of doing the work without profit. This is another test of his "responsibility."

Give Contractor Square Deal

Consider the contractor as honest and well intentioned and human, until he shows himself otherwise; if it be found that he cannot be dealt with on that basis, as H. G. Shirley said at the Road Builders' convention in Louisville recently, kick him out and brand him as dishonest. Do not try to get the contractor to do something without profit—it is expensive to the public in the end.

Cut out some of the fads, such as the cylinder or cone test for determining whether concrete is too wet or not. What does the average inexperienced engineer or inspector know about the interpretation of such a test!

Don't leave anything to the interpretation of the field engineer or inspector, who is usually conscientious but inexperienced, which may put him in a position to delay and harass the contractor by an unreasonable and generally incorrect interpretation.

Let the state make prompt allowance on the monthly estimates for the cost of aggregate material and of unloading and piling it as received at the site, permitting the contractor to accumulate large stock-piles at fixed points along the projected work. This will also permit the producer of the aggregates to work more efficiently and therefore more economically.

Let the state limit the amount of money retained to a reasonable amount, and as soon as sections of highway are completed and turned over for public use make a final estimate on that section. This will lower the cost of financing the work.

Eliminate from the specifications while common labor is so scarce and expensive as much of the hand labor in sloping and ditching as is possible.

Assure the contractor that the state engineer will not be unreasonably technical in interpreting such items of the specifications as require interpretation by him.

In short, establish and insist on a co-operative basis as between the engineering and the contracting organizations; by this I mean require it from the contractor's organization as well as toward it.

At the recent meeting of highway contractors at the annual meeting of the Associated General Contractors in Chicago, it was apparent that the contractors are trying to cover each and every one of the above items in their bids, and as each and every one of them cost them money why should they not charge for them?

Therefore, if the public wants cheaper highways, without sacrificing the type of construction, suppose we give some consideration to the facts in the case and get started on a business basis?

Operation of Trains as Affected By New Wage Schedules

Will It Be Economical To Operate Heavy Freight Trains as at Present or To Run Lighter and Faster Trains?

(Abstract of Committee Report, American Railway Engineering Association)

WHETHER railway improvement plans and operating methods will or will not be affected by changed operating conditions resulting from the new wage scale of train crews is a matter on which conflicting opinions exist in the American Railway Engineering Association's committee on railway location. That radical changes will be made in methods of handling freight in lighter and faster trains and in providing additional running tracks rather than reduced grades was the opinion expressed in the majority report of the committee, reviewed in *Engineering News-Record* of March 25, p. 602.

In a subsequent minority report by one member of the committee the above opinion is combated, on the ground that it magnifies the importance of speed and minimizes the importance of tonnage and grades. It is pointed out that three years ago the railways contended that even with an eight-hour day and 1½-time pay for overtime it would be economical to continue present methods of operation. In other words it would be better to handle freight traffic in the enormously heavy but slow trains now operated rather than to increase speed by such expedients as reducing train loads, increasing track facilities or increasing power.

That marked reductions in train loads will not be necessary to meet the new wage conditions is the opinion also of G. D. Brooke, superintendent of transportation of the Baltimore & Ohio R.R., as expressed in a paper appended to the report of the same association's committee on economics of railway operation.

It is pointed out that different conditions affect the speed of different classes of freight trains. The speed of quick dispatch or preference trains is governed by the traffic or service conditions. Local or way freight trains and other trains having a great deal of switching and other work at stations have to move rapidly between stations in order to maintain schedules and to prevent the total time on the road from becoming excessive. In reducing the hours of service of the crews of such trains it is necessary to deal with other features of operation than the speed between stations.

With slow or high tonnage freight trains the time of moving on the road forms a large percentage of the total time, and the speed of the trains has an important bearing on the tonnage hauled and consequently on the cost per ton mile of the transportation. The speed of such trains in ascending the ruling grades of the engine district is a governing factor in fixing the tonnage rating of the engine. Conversely, the tonnage rating assigned to the engine governs the speed of the train on the ruling grade. And the speed on the ruling grade determines to a greater or less extent, depending on the number or lengths of ruling grades, the average speed of the train over the district and the number of hours required to make the run.

Mr. Brooke states that while conditions on engine districts vary widely, the principles involved will be the same. By small reductions of the train load on the ruling grade trains will be enabled to start more quickly; sidings can be entered and left more promptly; the engine and train crew will have more confidence in their ability to move with precision and will be better able to take advantage of any situation to advance the movement when opposing or following trains are involved.

On the other hand, high speeds on ruling grades will require such reductions in trainload that the number of trains will be greatly increased, with resulting interference. Aggregate train hours required to handle the tonnage will remain high and the cost per ton mile will be increased.

For these reasons Mr. Brooke advocates small reductions in tonnage rating where any are necessary, while he considers that proposals for large reductions in trainload should be scrutinized with care and adopted only after exhaustive study permits of a positive conclusion that they are warranted.

Resistance of Greenheart to Marine Borers

Greenheart timbers placed in the Gulf of Mexico six years ago in waters infested with pholas, xylotra and limnoria were recently examined to determine the extent of injury by these marine borers. Limoria attached slightly one specimen on the sapwood. Xylotra did not gain entrance, but all timbers were severely attacked by pholas. The surfaces were covered with burrows from ¾ to ½ in. deep. How far the burrows will extend with continued exposure remains to be seen, but the experts of the Forest Products Laboratories, who placed the specimens, do not expect they will extend beyond 2 in. Pholas have not been found to bore very deep in wood. Piles of greenheart should be made large enough to allow for a reduction in size of pholas attack.

Other information which has been collected by the laboratory in various localities is given in an article by A. K. Armstrong in *Engineering Record*, Feb. 5, 1916, p. 180.

Add Interior Braces and Stirrups to Concrete Tankers

Weaknesses Revealed by Test of Government Ships Corrected by Strengthening Hull After Concrete Had Been Placed—New Struts Added to Permit Center Docking—Eight Ships Affected

CERTAIN structural weaknesses, discovered in tests and confirmed by analytical computations, have led to some changes in the framing of the 7,500-ton concrete oil tankers now being built in four yards by the United States Shipping Board. The corrections are mainly by way of adding more shear steel in the outer main frames, though at the same time additional interior bracing is being placed in order to make possible the docking of the ships on the center keelson, a load condition for which they were not originally designed. The work has been going on for some months and is now nearly complete. It is interesting from more than a shipbuilding viewpoint because of the possibility of the extension of the method of strengthening to any reinforced-concrete structure.

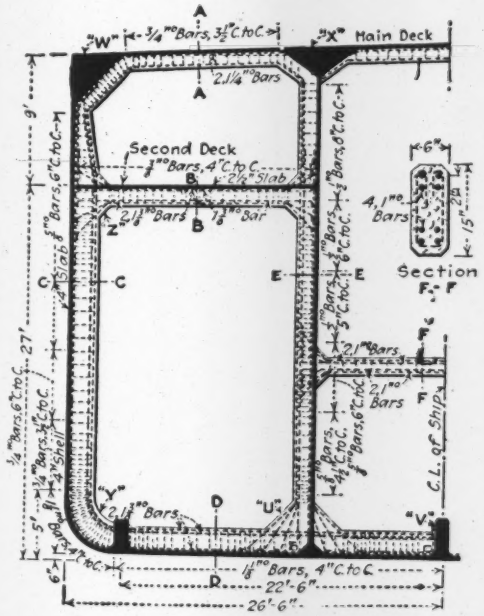


FIG. 1. CROSS-SECTION OF 7,500 TANKER AS ORIGINALLY DESIGNED
Reproduced from *Engineering News-Record*, Nov. 28, 1918

The government concrete oil tanker was designed in the Concrete Ship Section of the Emergency Fleet Corporation in the summer of 1918, and work was started on the two tankers in each of the four government yards, at Oakland, Cal.; San Diego, Cal.; Mobile, Ala., and Jacksonville, Fla. The original contracts called for ten of the tankers, but this was subsequently reduced to the eight noted. Work progressed on the vessels favorably and on May 29, 1919, one of them, at Oakland, was launched. Soon after, some of the tanks were tested under hydraulic head, with a resulting failure in three tanks. Following this a complete restudy of the design was made, with special reference to the conditions of construction as recorded in photographs or in the memory of those connected with the ship. As a result the revisions and repairs now being made were decided upon. Inasmuch as all of the hulls had by this time been completed, it was necessary to repeat the revisions on all of the remaining seven ships, as well as on the one in which the original failure occurred.

The 7,500-ton oil tanker is the largest concrete vessel ever attempted. It is 420 ft. long between perpendiculars, with a length overall of 434 ft. 3 in.; its molded depth at the side is 36 ft., its beam 54 ft., and its design loaded draft, 26 ft. Simplified ship lines are used in the design of the hull. About 50 per cent of the midlength of the boat is practically rectangular in section, the only divergence from rectangularity being the 6-in. dead rise, the 10-in. deck camber, and the circular bilge curve. A typical section is shown in Fig. 1.

Except for the boiler-room space amidships the hull is divided by cross bulkheads about every 30 ft. and two longitudinal bulkheads about on the third point into oil tanks, and in addition fore and aft bulkheads form peak tanks at bow and stern. The main frames are spaced every 4 ft. 3 in. and with decks, shell and bulkhead slabs form a monolithic structure as the typical section shows. A cross-brace holds the two longitudinal bulkheads at about one-third their height on the line of the frame and an intermediate deck separates the outer line of tanks into the summer and deep tanks. For longitudinal bracing there are two bilge keelsons and one center keelson, together with four longitudinal deck beams as shown.

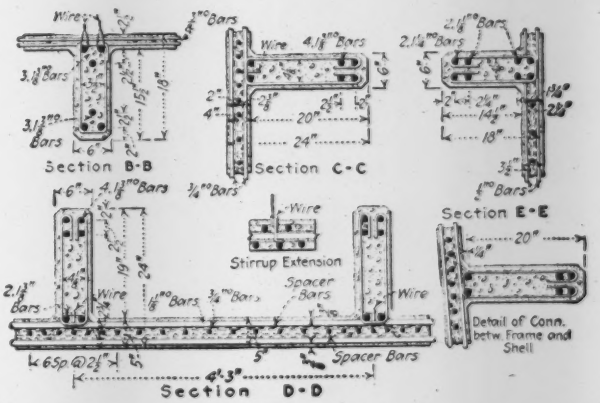


FIG. 2. FACSIMILE REPRODUCTION OF THE SHELL AND SLAB DETAIL CONNECTION AS DESIGNED

It was the practice of the Concrete Ship Section to design the reinforcement for the ships in the head office at Philadelphia, but to permit each of the yards to alter or revise these details as they saw fit provided the general principles laid down in the original drawing was adhered to. To guarantee this all prospective revisions of detail had to be approved in the home office. In consequence of this practice details of reinforcement differed in the four yards and all differed in some respects from the original design, which was outlined in *Engineering News-Record*, Nov. 28, 1918, p. 986. In general, however, the difficulties in the design were involved in the original design of the frames and their connection to the shell or bulkhead slabs. These difficulties are

reflected in insufficient or improperly placed stirrups in the frames.

It was the original intention in the design of the tanker to prefabricate the main frame steel, which was made up of 1⅜-in. rods in the original design, with four such rods at the free side and two rods at the shell or slab side of the frame. Both on the ground of economy and speed of erection it was decided not to attempt to thread these large rods singly into the frame fabric, but to make them up outside the ship and to swing them complete into place, a practice being successfully followed at that time on some of the smaller concrete barges. This decision, however, made necessary the peculiar frame and slab connection detail shown in Fig. 2. While this particular detail is the connection between frame and side shell, it is repeated in different sizes and arrangement in all parts of the ship where a frame and a slab come together. In this detail the frame steel, consisting of four inner and two outer longitudinal rods circled by a stirrup, is quite independent of the shell with which it has concrete attachment; in fact the outer two bars are on the frame side of the shell and about at the neutral axis of the frame and shell if they acted as a T-beam. In order to make some connections there is shown a secondary stirrup hook looping over the frame bars and underneath the outer row of shell steel. This hook was shown in the details of the bottom and side shell, but not in the deck detail where the normal load comes on the slab down onto the beam, as in a floor, but where under some conditions of tank loading there would be an upward pressure tending to force the deck slab away from the beam. In the bulkhead frame it was evidently not considered possible to pre-fabricate the frame for here the longitudinal frame steel nearest the slab is shown inside the slab steel.

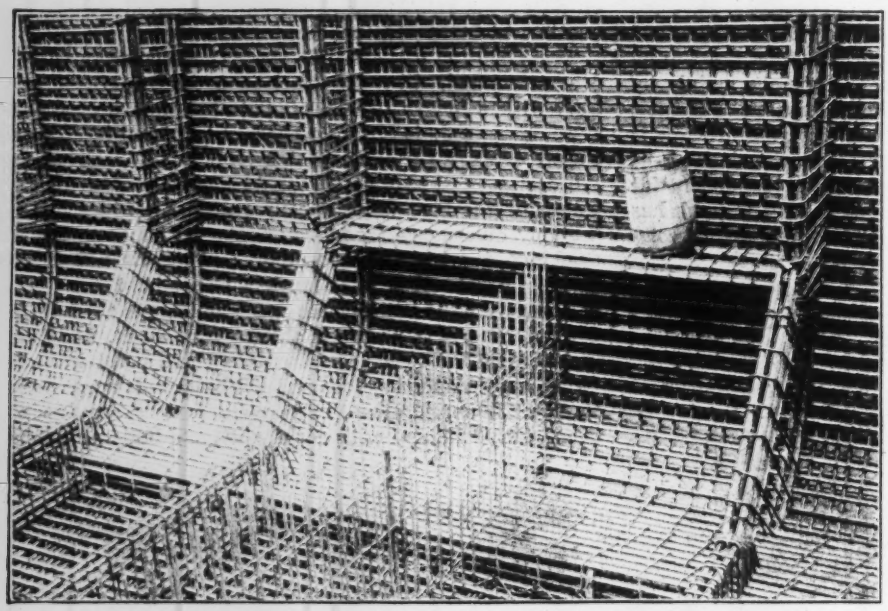


FIG. 3. FRAME AND SHELL STEEL IN PLACE IN TANKER AT SAN DIEGO YARD

In construction, this detail was soon found impracticable. In fact no pre-fabrication of complete frames was attempted. Furthermore, in most instances the weakness in the detail connection between slab and beam was recognized and a detail was placed which corrected the weakness. It was not possible, however, to thread the heavy longitudinal frame steel, although in some yards this had been changed to three 1-in. rods instead of the two 1⅜-in. rods. In consequence the tie or connection between the frame and slab steel consisted in extending the stirrups around some of the shell steel as shown in one of the typical methods in Fig. 3.

The location of this steel and its sufficiency became serious matters after the blowout of the tank in the San Francisco tests. Two failures occurred here in the first ship, one in the forepeak tank outer shell, the other in an intermediate oil tank inside bulkhead. The former was under a head 2½ ft. above the main deck, the latter under a head of 33 ft. above the bottom of the ship. In both cases the shell or slab was pushed away from the frame in a progressive failure which extended over several frames.

Investigation showed that at the forepeak tanks the frame steel was free from the shell steel, as shown in the design details, but that the small hook shown in those details was not included. In fact, so far as can be found out such a hook was never used in any of the ships any place. In addition to this, however, it was found after the forepeak tank failure that there were no stirrups either shown on drawings or placed in the structure connecting the frame to the shell at the intersection of a crossbrace beam with the frame. This apparently was an oversight in design which was not corrected in construction. In the mid tank which failed apparently the stirrup connection to slab steel was inadequate.

Investigation showed, therefore, that under the outward pressure of the tank's hydraulic load there was nothing to resist the pushing off of the shell from the frame but the tension of the concrete at the head of the frame. The stresses here are somewhat indeterminate, but it has been figured that the unit tension in the concrete across this frame head was about 150 lb. per square inch. Tests on the concrete in the ship gave breaking tension of about 400 lb. per square inch. It should be noted, however, that if one part of the concrete fell below the breaking unit stress and failure occurred there, load and stress conditions would immediately become unbalanced and a continuation of the break might readily take place. This failure led to a complete study of the design and construction of the tanker, and in addition to an investigation of the shear resisting provision in the frames. After a thorough investigation, which was hampered somewhat by the absence from the files of the Concrete Ship Section of certain fundamentals of the design, it was decided that the original and designing analysis of shear in the frames must have been made for loads of less

intensity than those for which the ship was tested or which, at this later date at least, it was decided should be governing. A new analysis was made on two new basic assumptions; the first, which is the underwriters test load, was for a hydraulic head of water in the tanks of 8 ft. above the deck, with the ship on the ways; the second, a working load, was for the tanks full of oil and the ships in 12 ft. of water. The former was based on tension in the steel of 24,000 lb. per square inch with correspondingly high figures in other stresses; the latter on design stresses, that is 16,000 ft. per square inch in steel, etc. The new analysis showed that in the frame stirrups as detailed the governing stresses of the alternative loads were much greater than safety permitted. Meanwhile a similar forepeak tank test had been started on the other ship at the Oakland yard, with practically the same results which had taken place in the first test. It was decided that in order to bring

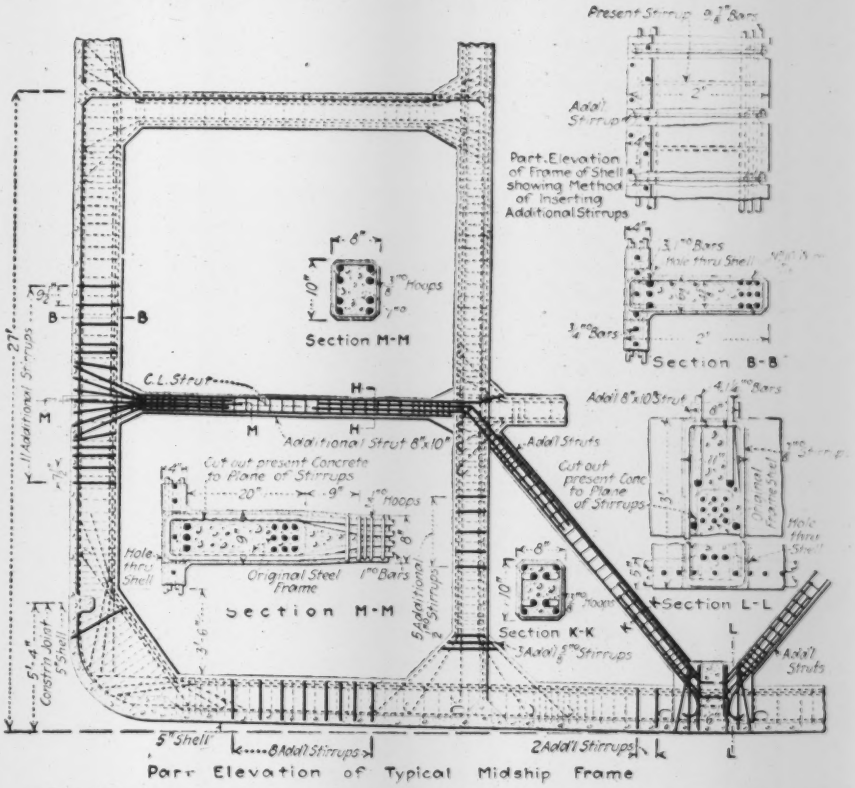


FIG. 4. METHOD OF CORRECTING FRAME OF THE CONCRETE OIL TANKERS AS ADOPTED AT OAKLAND YARD, EMERGENCY FLEET CORPORATION

General method of making these corrections were prescribed by Emergency Fleet Corporation's home office at Philadelphia, but the details were made for each yard at the yard's designing office.

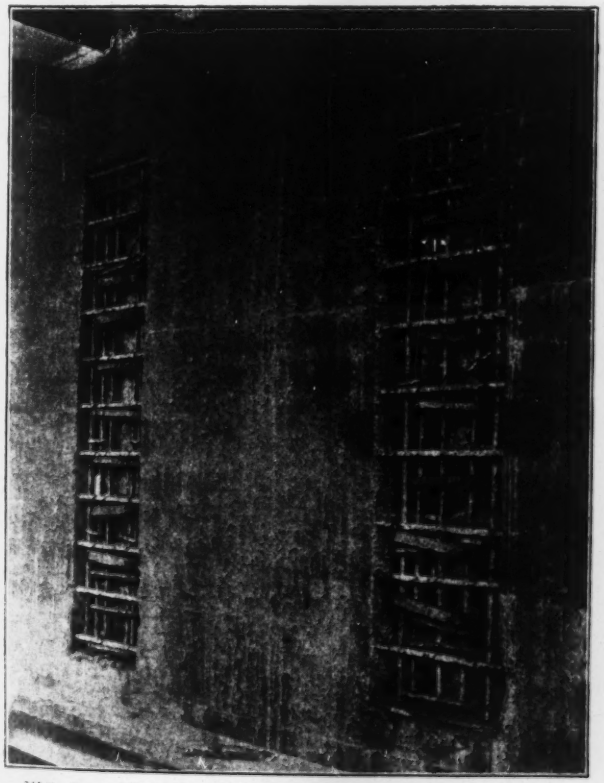


FIG. 5. CUTS OPPOSITE EACH FRAME AT NEW MID BRACE IN SHELL OF CONCRETE OIL TANKER

the stresses down to a safe limit immediate revision of the structural frame of all the tankers be undertaken.

In brief, these revisions consist of the insertion in each side tank opposite the center tank brace of an extra brace which could cut down the span length of the side frame and thus reduce the shear everywhere, except on each side of the brace. The extra shear here is to be taken care of by placing extra stirrups, in the method described hereinafter, but in addition a sufficient number of new stirrups are placed along the frames and bulkhead beams so as to provide full resistance to the new shear stresses as figured for the full test load of the latest investigation. This latter meant that the actual shear rod distribution had to be gone over in the light of the new shear stress diagram and wherever deficiencies of steel were found an additional stirrup is placed.

In determining upon the location of these new stirrups photographs of the existing work were used extensively. These photographs have been taken in each of the yards in great profusion, so that the location of practically all of the steel in the shell could be ascertained by study of such photographs as the one shown in Fig. 3. In the cases where the frame steel could not be located by photographs, record plans or by the memory of the men in charge of the work, cuts were made into the concrete along the edges of the frames to locate stirrups.

Further repairs were also made in the way of provision for center keelson docking. Naval design, which governed in the early days of the Concrete Ship Section, provides that ships are to be supported in docks

by blocking under the longitudinal bulkheads and each ship is furnished with a docking diagram which is followed to keep docking stresses within safe limits. It is a fact, however, that most floating dry docks will not take heavy concentrated loads off the center line on account of the arrangement of their underframing. Nevertheless floating docks must be used for most merchant ships, such as the oil tankers, which as designed cannot be docked safely under the center keelson. To remedy this defect, then, the diagonal struts shown in Fig. 4 rising from the center keelson were added at every frame of the hull of the tanker. These struts merely serve to transmit docking stresses up into the bulkhead frames and are not required for any other purpose.

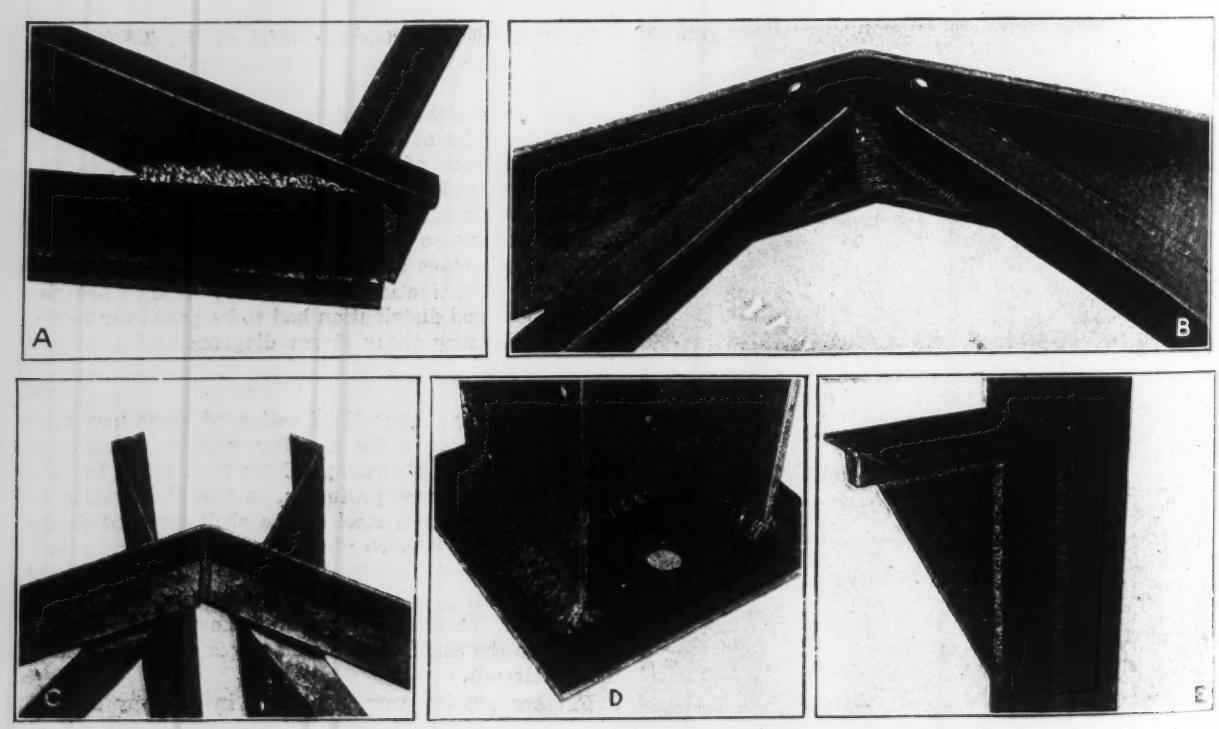
The new construction, therefore, consisted in pouring new braces in struts as shown, joining such members integrally to the existing concrete and placing new stirrups as required. The difficult and novel feature is the juncture of the new to the old concrete. In the case of the new stirrups this was done by first cutting with an air chisel in the frame a channel wide enough to carry the ½-in. stirrup and deep enough to reach down to the embedded longitudinal frame steel. Then a hole was cut in the shell or slab and a channel cut deep enough to insure complete embedment of the stirrup. The stirrup bent in a U was then inserted through the hole of the shell and its end, protruding beyond the end of the frame, heated by a torch and bent down and wired tight around the frame steel. The groove and hole were then filled tight with concrete mortar applied with the cement gun.

The juncture of the new crossbrace of the shell was made in the same general manner. As shown in Fig. 4, this joint is strengthened by fanning out the main rods of the brace to tie into the vertical steel of the shell. In one of the yards at each frame a clean cut was made in the shell concrete, as shown in Fig. 5, exposing all of the shell steel opposite the frame. The heavy horizontal rods hooking over the vertical rods are for the reinforcement of the new crossbrace shown in Fig. 4. Vertical rods shown in the view were designed to be spaced 2½ in. center to center. The new brace reinforcement was hooked around this steel and extended back into the forms for the brace. Concrete was then poured against forms placed flat against the opening. The shells and slabs which failed under test are being completely replaced, with additional steel to insure the tying of the slab to the frame. Concrete is removed well back of the line of visible fracture and the replaced concrete poured inside forms, just as was the original structure.

In other yards holes were drilled through the shell and the new rods run through in the same manner as for the additional stirrups, there being no large opening cut as in the view in Fig. 5.

Electrically Welded Mill Building Under Erection in Brooklyn

Following a successful load test carried out two weeks ago under the supervision of the Department of Buildings of Borough of Brooklyn, New York City, a small mill building in which all parts of the steelwork are welded with the electric arc instead of being riveted, is being erected in Brooklyn for the Electric Welding Co. of America, by T. Leonard MacBean, engineer and contractor. The structure is about 60 x 40 ft., and has four roof trusses of 40-ft. span supported on 8-in. H-beam columns fitted with brackets for a five-ton traveling crane. In its general arrangement the structure follows regular practice, but the detailing is such



CLOSE-UP VIEWS OF DETAILS IN ALL WELDED MILL BUILDING

A—Heel joint of 10-ft. truss. B and C—Peak joint of truss, front and back sides. D—Colum base. E—Crane bracket, made by first welding parts togther and later welding complete bracket to column.

as to suit the use of welding, and all connections throughout are made by this process. A considerable advantage in cost and time is claimed for the welded connections, but in the present instance the determinative feature was not cost economy so much as the fact that the fabricated work could be obtained more quickly by buying the plain steel members and cutting and welding them at the site instead of waiting for bridge shop deliveries.

The roof was designed for a total load of 45 lb. per sq.ft., of which about 30 lb. represents live load. Each truss weighs 1,400 lb. The chords are 4 x 5 x ⅜-in. tees, while the web members are single 3 x 2 x ¼-in. angles. On the trusses rest 10-in. 15-lb. channel purlins spanning the 20-ft. width of bay. The columns are 8 x 8-in. H-beams, 19 ft. high, and the crane bracket on the inner face of the column is build up of a pair of rear connection angles, a pair of girder seat angles, and a triangular web plate, as one of the views herewith shows. Base and cap of the columns are made by simple plates.

All material was received on the job cut to length. A wooden platform large enough to take a whole truss was built as a working floor, the the chord members were laid down on it in proper relative position to form a truss when connected. The top chord was made of a single length of tee, bent at the peak point after a triangular piece was cut out of the stem. At the heel points of the truss the stem of the top-chord tee was lapped past the stem of the bottom chord tee, and when the two members were clamped together the contact seams were welded; the seam of the stem at the peak was also welded shut. Then the web members were placed in position and clamped, and their connections to the chord welded. All this welding was done with the usual steel-wire electrode passed slowly along the seam to be welded, depositing there sufficient metal to fuse with the seam edges heated by the arc, and at the same time to form fillets giving strength to the joints. The photographic detail views shown herewith bring out the nature of the resulting connections quite clearly.

Loading Tests

When the plans for the building were submitted to the Department of Buildings, Borough of Brooklyn, the proposal to weld the connections was approved only with the stipulation of a successful load test before erection. This test was carried out March 20. Two trusses were set up at 20-ft. spacing and braced together, purlins were bolted in place, and by means of bags of gravel a load of 48 tons was applied. This was sufficient to load the trusses approximately to their elastic limit. No straining or other change was observable at the joints, and the test was considered in every respect successful. The deflection of the peak, 0.0425 ft., did not change during 48 hours, and upon removal of the load at the end of that period a set of less than 0.01 ft. was measured.

Following the test, erection of the building was begun by Mr. MacBean as contractor for the structure. The connections of trusses to columns and of purlins and bracing to trusses are being made by welding just as were the truss panel-point connections, so that the building when completed will be free from bolt or nut connections and will be strictly all-welded. The welding is being carried out by the Electric Welding Co. of America.

Methods of Supervising Tie Renewals

(Abstract of Committee Report, American Railway Engineering Association)

TWO general methods of annual field inspection for maintaining control of tie renewals, so that ties will remain in service for their full life but will be removed at the proper time, are recommended by the tie committee of the American Railway Engineering Association, as follows: 1, By section foremen or their immediate superiors, or others directly responsible for the safety of the track; 2, By special inspectors chosen for their experience and knowledge of the requirements of their territory and not generally connected with or responsible for the track or territory inspected.

The first method has a tendency to provide adequate renewals, thereby assuring safety within the limits of available resources. It also provides a basic knowledge of local conditions, which no other method can cover. On the other hand, there will undoubtedly be a lack of uniformity under similar conditions on various territories and the possibility of excessive and uneconomical renewals.

The second method provides for training a small number of selected men to a predetermined standard of tie renewals and consequent conservation of ties. It presents difficulties, however, in possible inadequate renewals at certain points, inability to obtain sufficient men and difficulty in finding employment for them outside of the renewal season. Conditions on various railway systems are so different that no one method can be established, but the committee points out that consideration must be given to the local conditions in determining which method is best for any particular road.

Whichever method is used, the spotting or marking of each tie to be removed is advisable. The section foremen, however, should be allowed some latitude for removing ties, independent of the spotting, which are broken or damaged or otherwise injured. A check of ties removed from time to time is considered essential. The use of statistics for approximate determination of tie requirements in advance of field inspection will be found desirable. When the number of ties available is less than the final inspection requirements indicate as being needed, the supply should be prorated, making due allowance for local conditions of traffic, curvature, grade and roadbed.

Concrete Worms

Microbes that fed on steel rails were discovered periodically and reported in the columns of the *Engineering News* and *Engineering Record*. Now comes the first of the "Concrete Worm" stories emanating from western Nebraska where, it is suspected that sales competition is not unmixed with pleasure by rival material representatives. Approaching a wealthy taxpayer with the idea of divulging the latest information on the merits of concrete a Portland Cement Association field agent was rebuffed with the statement that concrete worms had eaten into the underside of the town's 6-in. cement walk to such an extent that a mere 1-in. surface crust remained. Further details credited the worms with an equipment of chisel teeth and miniature rock crushers for reducing the cement, which was preferred to the aggregate, to dust before complete digestion.

The Herschel Weir for Gaging in Open Channels

A Circular Hollow Crested Weir Giving a Straight-Line Formula Q = 5.50 d, Based on Differences in Pressure Above and at Crest, the First Corrected Automatically for Velocity of Approach

Abstract of a Paper by Clemens Herschel, Consulting Engineer New York City, to be presented at the Spring Meeting of the American Society of Mechanical Engineers, St. Louis, Mo., May 24 to 27, 1920. The first four paragraphs represent some rearrangement and condensation of statements in order to bring together certain historical and related statements.—EDITOR.

EXPERIMENTS on a new form of weir made by the writer at the hydraulic laboratory of the Massachusetts Institute of Technology in September and October, 1919, on behalf of the Power Test Code Committee of the American Society of Mechanical Engineers, with funds provided by Engineering Foundation, indicate that the type of weir suggested by the author more than twenty years ago gives a discharge represented by a straight-line formula, from 0 up to 9.55 cu.ft. per sec. per ft. in length of weir, and thus continuing, presumably, indefinitely beyond that quantity. Its equation is $Q = 5.50\ d$; d being the difference of two observations of water height or pressure; the one taken just upstream from the weir (taken so as to be automatically corrected for "velocity of approach," if one pleases, or corrected by computation before being used in the above formula, if preferred), and the other taken at the crest. In both cases d is obtained by measuring the elevation of a water surface in a pail by means of a hook gage, or otherwise as desired. This *difference* of pressures may also be obtained by means of one of the many apparatus already invented and on the market for measuring differences of pressure, in which case the register may indicate mechanically the quantity passing at any moment, sum it up for any given period of time, portray it graphically on a chart, or simultaneously do all three of these recording operations.

And the reason it does all this is because it is carried out with a weir that is not a "sharp-edged weir," the type that has rested like the incubus of an evil spirit upon the minds of all hydraulicians for full 200 years, ever since the Marchese G. Poleni first wrote about weirs in De Motu Aquae Mixto, Patavii, 1717.

In its general outlines, the new weir was described in *Engineering News*, Nov. 10, 1898. More particularly was it forecast in *Transactions* American Society of Civil Engineers, 1918, in a discussion by the writer of a paper by Floyd A. Nagler. So here was a case of an invention, or vision, if one pleases, in practical hydraulics, that had to wait twenty years in the brain of the engineer, for lack of public or private facilities to test it. An attempt to experiment as has now been done, was made some ten years ago, but was frustrated by the writer being informed by the manager of a richly endowed institution that its funds were available only for research in sciences that had no practical applications.

A United States patent has been applied for covering the weir construction herein described.

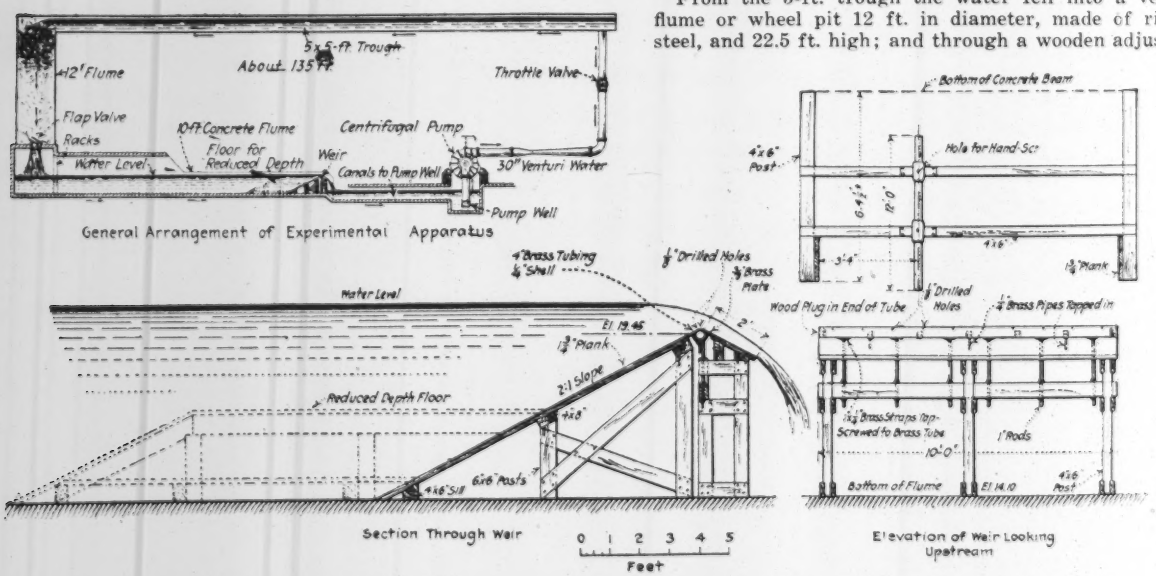
The apparatus used in the present experiments consisted of a 350-hp. Ball angle-compound engine, 240 r.p.m., direct-connected to a 30-in. Worthington centrifugal pump, having some 48 cu.ft. per sec. maximum capacity, at 40 to 45 ft. lift. This pump takes its suction from a system of canals under the floor of the basement, which is or may be connected with the Charles River Basin.

Right here arose one great obstacle in the making of these hydraulic experiments. The canals that have been named at times took to "surging," causing oscillations of the pump-well surface, and these, in turn, were transmitted through the pump, and could plainly be seen at the upstream end of the discharge pipe. They were also indicated by the 30-in. venturi meter set in line of the discharge pipe, next downstream from the pump. Two whole afternoons' work were rendered useless from this cause. But by experience and careful work, any gross effect from this cause could be avoided.

The discharge pipe delivered into a riveted trough of steel, 5 ft. by 5 ft. and about 135 ft. long; at some 40 ft. higher elevation than the pump. In it was set the 16-in. by 5¼-in. venturi meter, used to measure quantities smaller than about 8 cu. ft. per sec. (September 25, 26, and 29), the larger quantities being measured by the 30-in. meter already spoken of.

Both these meters were read by means of mercury straight-tube manometers, as made by the builders of the meters. The scale of these manometers was based on a coefficient of discharge for the meters of 0.99 and read tenths of cubic feet per second; and hundredths could readily be estimated, on both of the meters used.

From the 5-ft. trough the water fell into a vertical flume or wheel pit 12 ft. in diameter, made of riveted steel, and 22.5 ft. high; and through a wooden adjustable



(1) Details of Herschel Weir and General Arrangement of Testing Apparatus. The surface curve of the water discharging over the weir is drawn from measurement

flap valve in the floor of this flume, fell into a concrete tail-race pit, which, through racks and gridiron-valve gates, discharged into the concrete channel about 72 ft. long that led to the weir to be tested. The discharge of the weir fell back into the system of canals which fed the centrafugal pump, thus completing the cycle actuated by the Ball engine and pump.

To vary the discharge, the pump operating at a uniform speed as governed by a flywheel governor, and the boiler pressure also being fairly constant, a throttle valve in line of the pump discharge pipe was used. When the small 16-in. meter set in the 5-ft. trough was in action, the quantity and constancy of the flow leading to the meter and the efficient action of the pump, in spite of the small quantities lifted, could be regulated by opening a waste-valve out of the pump discharge pipe. To a minute extent, certainly sufficient to remove all air from the pump discharge pipe before it reached the 30-in. meter, the same office was performed by keeping in action a 2-in. steam siphon, set at the extreme upstream end of the pump discharge pipe and ordinarily used to exhaust air from the pump before starting it.

The concrete channel above referred to was nominally and almost exactly 10 ft. wide, and had at its downstream end a sharp-crested weir whose crest was about 5.35 ft. above the bottom of the channel. The new form of weir was so designed that it could be built over and around the old weir, and again removed without injury or displacement of what was found on the premises, and with its crest at nearly the same elevation above the bottom of the concrete flume.

The fundamental idea followed in the design of the new weir was to have the water to be measured conducted over the weir in a gentle manner, and so as to have it flow smoothly and regularly from the time it first encounters the weir construction until it leaves it. Instead of allowing the body of water to impinge with more or less violence, according to the velocity with which it approaches the weir against a perpendicular wall in its path (the upstream face of the ordinary weir) it is gently led to the crest by a 2:1 slope. Instead of striking or being torn over a sharp edge at the crest, the crest is made in the form of the arc of a circle; and instead of bothering about air under the nappe, the nappe is supported on another 2:1 slope downstream from the crest. Moreover, the crest is made hollow, so that observations of the pressure, or lack of full pressure, whichever the water may elect to exercise, can be taken *at* the crest, not at a distance upstream from the crest varying according to the fancy of the experimenter.

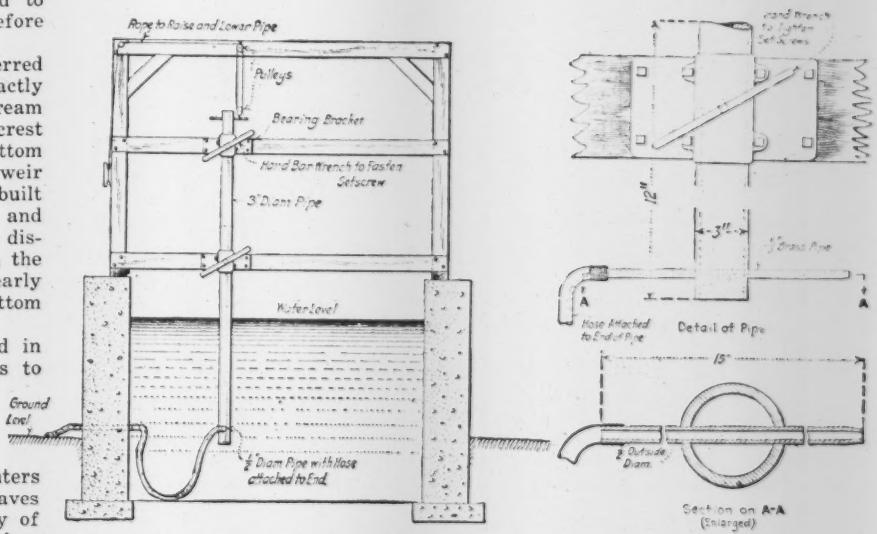
If the quantity passing the weir turn out to be a function of this observed pressure, well and good. If not, we will see what virtue there is in the *difference* of water elevations or pressures, the one taken upstream from the weir and the other taken by means of the hollow weir test. The difference referred to proved to be the sought-for solution of the problem at hand, and hereafter it alone will be closely considered. A United States patent has been applied for, covering the weir construction herein described.

The orifice in the side of the concrete flume conducting water to the hook-gage pail for measuring water elevations upstream from the weir was made flush with the flume side, at a point 13.9 ft. upstream from the weir crest center, and 1.68 ft. below it in elevation.

Furthermore, to connect the water passing over the weir with the hollow of the weir crest, a series of ¼-in. holes were carefully bored through into the latter. This was done by first tapping in a solid brass plug, and then boring a hole ¼ in. in diameter through this plug. A natural inclination would be to bore these holes at right angles to the surface of the water, but as this varies with the quantity passing the weir, such an inclination is impracticable. There are only two other natural directions for such piezometer holes—either vertical, or at right angles to the upstream slope of the weir; and if the latter, naturally at the line of tangency of that upstream slope and the arc of the weir crest. The vertical holes are called "Orifices No. 1" and those perpendicular to the 2: 1 slope "Orifices No. 2." The original intention of the writer had been to make the crest tube so that it could be revolved around its horizontal axis, and thus find the best position of the piezometer orifices, but a cumbersome and unduly expensive experiment like this was at once abandoned, and in view of the success already attained, may now be disregarded by engineers.

Both kinds of piezometric orifices were tried, and the last named proved much the superior for general use.

To vary the velocity of approach a false bottom was put into the channel for some of the experiments. These will be designated as having been made with "reduced depth," and others with "full depth."



(2) Apparatus to Observe Upstream Water Elevation, Automatically Corrected for Velocity of Approach.

To increase the quantity per foot in length of weir, the available capacity of the pump was in many of the experiments made to pass over only about 3.3 ft. of the length of the weir, while other series of the experiments used a weir about 10 ft. long.

As these experiments had a practically useful end and aim,—the establishing of a commendable method of weir measurements,—end contractions were ruled out from the very beginning. They are of no use ordinarily and only complicate the situation.

A vertical brass pipe dipping into the water was intended as a means of observing the water elevation upstream from any part of the weir, automatically corrected for velocity of approach by taking in the water pressure through a pitot orifice pointing upstream and transmitting it to a hook-gage pail in the usual manner from out of the downstream side of the vertical tube. A pointer above water, parallel to the pitot tubular orifice, which should point upstream, insures its correct position. Our experience leads us to advise that the vertical tube be not used as a reservoir, but only as a support for the pitot orifice.

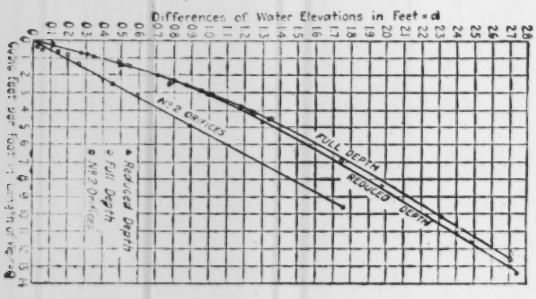
The tube is held in its guides by two clamp screws, and may readily be set, so as to bring the pitot orifice in the locus of mean velocity as it may be judged or found. In these experiments it was set at 0.6 depth of water, and ½ the width of the channel from either side. A scale of feet and tenths on the tube, reading up from zero at the pitot orifice, and aided by another scale or gage painted on the

side of the concrete flume, reading up from zero at the flume bottom, readily permitted this. The apparatus is mounted on two beams crossing the water channel.

This apparatus exists as yet only in theory and should be experimented with at the first favorable opportunity, because on drawing the water out of the flume at the close of our experiments, a broken and leaky joint was discovered in pipe that carried the water pressure from the vertical tube to the hook-gage pail, so that the readings taken proved of no record value whatever.

Our weir crest had a radius of 0.198 ft., and the outside surface was hard and smooth oil paint. No doubt the radius of the weir crest is a factor in the application of the formula found for weirs of the construction shown in this article, but it remains for other sets of experiments to reveal the limits and detailed effects of this radius. This illustrates the need there is for a hydraulic observatory, to be conducted on similar lines to those followed for so many centuries.

With these preliminary statements, the record of the 40



(3) Diagram Showing Results of the 40 Experiments.

experiments made is given in the accompanying table. Four of them have been marked doubtful on account of actual or supposedly defective observations and all those made Sept. 9 and 30, also part of those on Sept. 25, had to be rejected as worthless on account of the previously mentioned violent "surging" of the water discharged by the pump.

A separate set of gagings was made Oct. 3 to compare the indications of the Institute's sharp-edged weir with the Institute's 30-in. venturi meter. Owing to the fact that this meter is set in line of the pump discharge pipe, only 12 ft. distant from the pump, it had been a question whether at that short range it would meter accurately, and the experiments of Oct. 3 were made for the purpose of answering this question. The system available for observing head on the weir, was that known as the Fteley and Stearns method. A metal plate was set in the side of the concrete flume, flush with it, and an orifice in this plate, in the present instance, was situated 6.8 ft. upstream from the crest and 1.68 ft. below it in elevation, connected with a hook-gage pail in the usual manner.

Record

Pump started about 12:30 p.m., discharging 30 cu.ft. per sec. at 1 p.m. All quantities corrected for velocity of approach.

		Weir Cu.Ft.	Meter per Sec.
Oct. 3, 1919.	2 05 to 2 10 p.m., both inclusive	38.13	38.30
	2 50 to 2 55 p.m., both inclusive	30.33	31.25
	3 50 to 3 55 p.m., both inclusive	17.91	18.80
	4 40 to 4 45 p.m., both inclusive	11.73	11.00

Having in mind the imperfections of the whole test apparatus from the canals in the basement, through the pump, riser, 5-ft. trough, 12-ft. vertical flume, wooden flap valve, into the 10-ft. concrete flume, and over the weir (as already mentioned), it is quite possible that 38.13, 30.33, 17.91, and 11.73 cu.ft. per sec. were passing the weir on the average for 5 min., while 38.30, 31.25, 18.80, and 11.00 cu.ft. per sec. were being discharged by the pump on the

LOG EXPERIMENTS WITH THE HERSCHEL WEIR

Date, 1919	Length of Run, P.M.	Velocity of Approach, Ft. per Sec.	Depression = Piezometer d = Height (Corrected for Velocity of Approach) Less Weir Indication. As Measured	Corrected for v. of a	Quantities per Ft. of Weir Length Cu. Ft. per Sec.
Sept. 10[1]	2.45–2.50	0.70	1.332	1.340	4.53
	4.00–4.05	0.58	1.182	1.187	3.82
	4.30–4.35	0.48	0.991	0.995	3.06
	4.55–5.00	0.33	0.700	0.702	2.03
Sept. 11[1]	1.50–1.55	0.24	0.522	0.522	1.49
	2.20–2.25	....	0.347	0.347	0.95
	2.50–2.55	...	0.279	0.279	0.75
	3.20–3.25	0.24	0.508	0.508	1.42
	3.55–4.00	0.45	0.962	0.965	2.82
	4.45–4.50	0.62	1.240	1.246	4.07
Sept. 15[2]	2.15–2.20	1.24	1.319	1.349	4.48
	3.00–3.05	0.92	1.001	1.014	3.14
	3.50–3.55	0.72	0.790	0.798	2.34
	4.25–4.30	0.50	0.529	0.533	1.53
	4.55–5.00	0.30	0.305	0.307	0.85
Sept. 17[3]	2.30–2.35	1.62	2.683	2.723	12.53
	3.05–3.10	1.39	2.279	2.309	10.18
	3.40–3.45	1.00	1.725	1.741	6.87
	4.20–4.25	0.63	1.229	1.237	4.13
	4.50–4.55	0.40	0.864	0.868	2.57
Sept. 18[4]	1.55–2.00	2.87	2.603	2.733	13.38
	2.30–2.34	2.60	2.374	2.484	11.53
	3.05–3.10	2.01	1.915	1.977	8.31
	3.50–3.55	1.28	1.269	1.294	4.63
	4.35–4.40	0.75	0.773	0.782	2.45
Sept. 25[4]	3.10–3.15	0.40	0.478	0.482	1.33
Sept. 26[4]	1.43–1.45	0.47	0.491	0.495	1.42
	3.05–3.10	0.25	0.265	0.265	0.71
	4.10–4.15	0.13	0.120	0.120	0.367
	4.40–4.45		0.101	0.101	0.247
Sept. 29[5]	3.15–3.20	0.42	0.249	0.253	1.30
	3.55–4.00	0.29	0.194	0.195	0.87
	4.25–4.30	0.18	0.149	0.149	0.51
	4.45–4.50	0.18	0.042	0.042	0.49
	5.05–5.10	0.08	0.022	0.022	0.21
Oct. 1[5]	1.30–1.35	2.22	1.658	1.738	9.55
	2.10–2.15	1.90	1.189	1.249	6.91
	3.10–3.15	1.34	0.865	0.895	4.93
	3.45–3.50	0.92	0.581	0.593	3.14
	4.20–4.25	0.73	0.438	0.447	2.42

[1] Long weir, full depth.
[2] Long weir, reduced depth.
[3] Short weir, full depth.
[4] Short weir, reduced depth.
[5] Short weir, reduced depth, No. 2 orifices.

average, during the same 5 min. The difference could very well represent rise or fall in the mean elevations of the water in either the 5-ft. trough, the 12-ft. vertical flume, or in the 10-ft. concrete flume, or in two or more of these containers simultaneously.

The comparison which was made, taken by itself, does not argue for a superior exactness of gaging, by either the weir or the meter—that must be determined by tank tests made with the two separately. It only showed that neither was materially inexact. And we know from data that have been given above that the venturi meter gives water measurements closely approximating the exactness of tank tests. And with the result placed in evidence, that No. 2 orifices act according to the straight-line equation—

$$Q = 5.50d \text{ in English units,}$$
$$Q = 1.67d \text{ in metric units,}$$

this paper might fitly close.

One word more, however, the writer allows himself in relation to formulas for weir discharge. It had been his intention not to evolve any formula, but to present the result of his experiments in the form of a table, arranged somewhat as are tables of logarithms, so that quantities could always be read at a glance from the data observed. No one cares for the formulas by means of which logarithms are computed; their use would not be furthered by a study of them. No more need a Power Test Code contain formulas for weir discharge; a table would answer its purposes more fittingly.

But the exceeding simplicity of the weir formula appurtenant to the form of weir herein presented upset this plan. Such a weir does not need so much as a table to look up or to compute its discharge. All one has to do is to measure the length of the weir and multiply by 5.5 and the difference in head.

Studies of Maintenance Work on Drainage Ditches

Conclusion Reached That Channels Should Be Cleaned Every Year—Banks at Three to Five Year Intervals

By H. M. Lynde
Senior Drainage Engineer, U. S. Bureau of Public Roads, Washington, D. C.

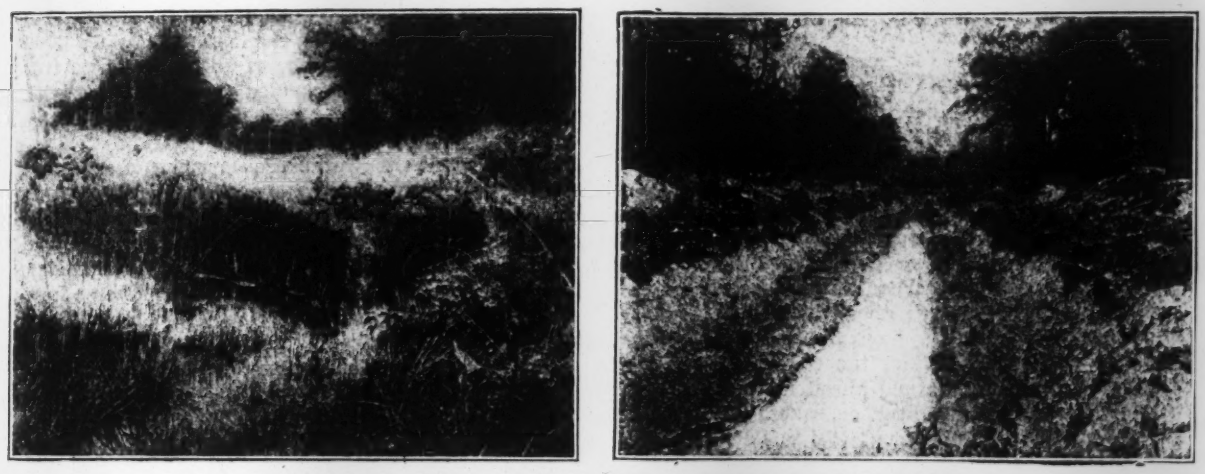
That the channels of drainage ditches need to be cleaned annually to insure proper flow capacity and sanitary conditions, but that the banks need be cleared only at intervals of from three to five years, are conclusions based on experiments described below.

In many drainage districts in the flat, coastal plain section of North Carolina the flow in the main ditches is so slight during a large portion of the year that the water follows a winding course over the wide bottom of the ditch, allowing vegetation to spring up on the uncovered portions and where the water is stagnant. This growth furnishes lodgment for silt, so that after a few seasons the channel may become almost completely choked. Practically no maintenance work has been done in this region, but the removal annually of sand bars, logs, trees, stumps, tree tops, drift, fences, foot logs and débris becomes a necessity if the ditch section is to keep its original efficiency. The opening up of new land requires attention to the outlets of field ditches emptying into the main waterway in order to reduce the discharge of dirt which tends to form bars in the channel.

To determine the best methods of maintenance and the cost of this work, a typical section of dredged ditch about two miles long through Jacob Swamp, in Robeson County, was selected for experimental purposes by the Division of Drainage Investigations, Bureau of Public Roads, U. S. Department of Agriculture. The clearing was done in April and May, 1917, and suspended in 1918 on account of the war, but was renewed in May and June, 1919, and is to be continued. It may be classified under the following heads: (1) Clearing banks; (2) clearing ditch of plant growth and débris; (3) removal of sand bars; (4) excavation of low water channel; (5) construction of outlets for field ditches.

The work was done by force account and complete records of details and cost have been kept, from which it is hoped to establish a basis for reasonable prices for letting work of this character. Labor consisted of whites, Croatan Indians and negroes, working 8 hr. a day. In 1919 the foreman was paid $5 and common labor $2.50 per day; two of the men were paid $2.75 and finally $5 per day. Labor was scarce and the force averaged only five men and the foreman. The men furnished their own tools, but rubber boots were supplied. In 1917 the foreman was paid $2.50 and common labor $1.50 per day, with two skilled men at $1.75, while the force averaged about ten men and the foreman.

Jacob Swamp is flat, heavily timbered and varies in width from 150 to 800 ft., while its drainage area also is flat and contains 9,980 acres. The 9-mile ditch has side slopes of ½ to 1 and 14- to 16-ft. bottom width. For the upper 7.2 miles the fall is 2.64 ft. to the mile and for the lower end 3.70 ft. per mile. Its average depth is 6.5 ft., and it is capable of removing a run-off of over ¾ in. in 24 hours, when flowing with 5.5 ft. of water.



JACOB SWAMP DRAINAGE DITCH BEFORE AND AFTER CLEANING
(Views taken from the same point)

For the maintenance work a section was selected where the grade is 2.64 ft. per mile. The bottom is in sand, solid under foot. The excavated material is sand, sometimes mixed with clay. Very little of the land along the ditch is under cultivation.

This ditch was constructed in 1913, and by 1917 it was choked with a heavy growth of plants, principally cat-tails, rushes, sedges and willows. The banks also sustained a heavy growth, mainly sedge, dog fennel, willows and briars. A few trees and stumps have fallen into the channel and at places foot logs have been thrown across near the water level. Sandbars have formed in the main waterway, at the outlets to many of the farm ditches. The ditch in general, however, has not filled appreciably, and there has been very little deterioration in the banks.

In 1919, the plant growth was as dense as in 1917, but there was a noticeable absence of woody growth like willows. Cat-tails were abundant, and stretches of 100 to 200 ft. were solid with this plant, taller than a man. The other growth in the channel was largely rushes and sedges. The growth on the banks was not as heavy as in 1917.

The Jacob Swamp ditch, like many others in the state, is large for the amount of water it carries, normally. At certain times of the year there is little, if any, flow. Its condition as compared with that of Back Swamp ditch in the same district, but having a considerable flow of water throughout the year, is striking. On Back Swamp there is practically no growth in the channel, at least at its lower end. It is true that its fall is 3.43 ft. to the mile, as compared to 2.64 ft. on the Jacob Swamp ditch, but this is not thought to be the cause of the difference in condition.

Method of Clearing the Ditch

Brush hooks, machetes and axes were used for clearing the banks. Burning was employed in 1917, but only on a limited scale in 1919, owing to the dry weather and the danger of fire getting into the woods. In cultivated land, burning is recommended as the best means of clearing the banks after the brush has been cut and piled; also for getting rid of sedge. All overhonging stumps and trees on the edges of the banks were removed, and if not too large were rolled to the outer side of the waste bank. One man averaged about 310 ft. of bank clearing per day in 1917, and about 600 ft. in 1919, but the banks were not cleaned as neatly in 1919. Piling and burning averaged about one mile a day for the entire force in 1917.

Clearing the channel of plant growth, logs and other débris is the heaviest and most important part of the maintenance work. This was done entirely by hand, using hoes and rakes, pitchforks, brush hooks, machetes and axes. In ordinary going the principal tools were hoes or rakes and pitchforks. Work proceeded upstream.

When the force for cleaning the channel was sufficient, four or five men worked ahead and cut out all growth by the roots with hoes or rakes (the potato fork was found to be an efficient tool), allowing it to lie flat on the surface of the water which averaged about 10 in. deep. Two or three men followed to throw this débris out on the banks with pitchforks. At the beginning of the day's work a log was thrown across the surface of the water to catch any drift which passed the men. At the end of the day the drift that had accumulated was removed and the log was moved ahead next morning.

Willows and large growth generally were pulled out by the roots by hand and thrown on the bank. Where specially heavy growth was encountered some of the men went ahead and cleared it out with axes and brush hooks. Cat-tails generally were pulled by hand. Logs, tree tops and stumps were taken out at the same time the plant growth was removed, or were left for a return trip.

Progress depended upon the density of the growth and the force. In 1917 it ranged from 300 to 1,400 ft. per day, with an average of about 725 ft. In 1919 the range was 300 to 1,150 ft., with an average of about 530 ft., the force being much smaller and perhaps not as efficient. After the entire section had been cleared it was found advisable to work back downstream, to remove straggling plants and clean out a little more carefully along the edge of the ditch at the bottom of the banks. Generally this could be done at the rate of about a mile a day.

Six field ditches entered the ditch in 1917, which number had increased to 13 in 1919. Although the six ditches had been protected in 1917 by outlet structures, the sand bars in 1919 were as bad in front of these as at the outlets to the new ditches which had no protection. The material seemed to come from far up in the fields and not from the caving of the waste banks of the canal. These bars were not entirely removed in all cases. Generally a low-water channel 6 ft. wide was excavated through them and the material thrown out against the side of the ditch at the foot of the bank. No excavation of the low-water channel was done in 1919, and it is doubtful if this is necessary where the channel has filled less than one foot. The principal harm comes from the formation of sand bars. If these are removed, probably no low-water channel need be dug.

A uniform grade was given in 1917 by the excavation of a low-water channel 6 ft. wide, with an average cut of 0.34 ft. This work proceeded downstream. The tools used were long-handled round-pointed shovels, the white sand excavated being thrown against the side of the ditch at the foot of the bank. Progress depended upon the depth of excavation, the maximum being 1,700 ft. in one day, with an average of about 850 ft. After the channel had been excavated it was swept with brooms, this taking only about a day for the entire length.

Outlet structures to prevent the carrying of sand into the main waterway, due to the caving of the waste banks, are of doubtful efficacy, as noted above. They should be built of sound cypress or juniper logs and poles, if available, ranging from 3 to 8 in. in diameter. The bottom should be lined with short transverse logs, these being 3-in. logs or 8-in. logs split in half and laid with the flat side up. The walls should be of poles laid lengthwise, with upright posts placed 3 ft. to 4 ft. apart and braced at the top with poles. Grass or other material should be used to close the openings between the logs of the walls to prevent dirt sifting through.

This protection should extend from the edge of the ditch to a point beyond the outer or land toe of the waste bank. Where ditches enter above the level of the bottom of the ditch, drops should be made either of logs or lumber. Structures built of lumber are costly and are no more effective than are those built of logs. Whether they are any more permanent remains to be seen. Sand traps are not satisfactory unless made very large and watertight. If not large they soon fill, and if they leak the water will undermine the floor and walls of the flume.

Cost of Clearing

The cost of the different items of work for 1917 and 1919 are shown in the accompanying table, to which must be added miscellaneous expenses, such as spikes and nails. It will be noted that the cost per unit of length (including both banks) for clearing the banks was practically the same in 1919 and in 1917, although

COST OF CLEARING DRAINAGE DITCH IN NORTH CAROLINA

	Total Hours		Total Cost		Cost per 100 Ft.	
	1917	1919	1917	1919	1917	1919
Clearing banks	569	310	$112.97	$120.62	$1.08	$1.09
Clearing ditch	844	1,052	173.54	377.57	1.58	3.43
Excav. sand bars	84	102	17.15	36.25	.....	.....
Excav. low water channel	1,080	....	233 50	.....	2.12	
Outlets of side ditches	376	....	104.99	.....	Av. $21 each	
Total	2,903	1,464	$642.15	$534.44	.....	

Note—Cost of outlets ranged from $7.50 to $40.46. The higher price included $22.46 for lumber, but all other outlets were of logs obtained along the ditch free of cost.

the cost of labor was higher in 1919. While the growth was not quite as thick in 1919, the width cleared was less and the material was not burned.

Clearing the ditch of plant growth and other obstructions cost nearly two and one-quarter times as much in 1919. The plant growth was somewhat more dense than in 1917, while the crew averaged only five or six men (constantly changing) and a crew of this size is not as efficient as is one of 10 or 12 men to one foreman. Moreover, wages were considerably higher in 1919, as shown already. Several more sand bars were excavated in 1919, which, together with the increased unit cost of labor, explains in part the increased cost of this item in 1919.

If the waste banks, berms and ditch banks were sodded with Bermuda or other suitable grass and pastured very little clearing would be required except to remove the aquatic plants from the bottom of the ditch, while pasture of considerable value would be provided. Farmers object to Bermuda grass, however, and no attempt has been made to introduce it. As cattle prefer this to the local grasses there should be no trouble in keeping the ditch banks pastured, even in communities where there is little stock. The cost of clearing banks has been about 20 per cent of the total, as shown in the table, if the cost of the outlets is excepted. Pasturing would tend also to reduce the amount of clearing in the ditch.

Plant Growth and Its Removal

That the eradication and control of aquatic plants is a difficult problem is indicated by the experiments. The growth can be removed temporarily, but conditions will be as bad in a year or two. Apparently the cost (if the price of labor remains constant) does not diminish from year to year, and about the same amount of money and labor needs to be expended in the second year as in the first. Woody growth like willows, etc., does not appear to come back readily.

Roots are difficult to remove, and most of them are perennial. Cat-tails, in particular, have a long root system extending horizontally from which spring up many stalks. Experience indicates that to get the best results, the plants should be removed when they have about reached their maximum growth, but before they have begun to seed or the sap has started down into the root system, as the plant is thus weakened for starting growth the following year. From the middle of June to August would be perhaps the best time, while there would be more labor available after the first of July, when the cotton is laid by and the curing of tobacco is well advanced. Experiments on a short section of ditch with plants in full growth above and below it cannot give reliable results, as seeds are carried by both wind and water to the cleared section and start a vigorous growth at once. Cat-tails and rushes are not very common in eastern North Carolina, and how they got their start in this ditch is a question for botanists. In building new ditches all cat-tail ponds should be drained and ploughed.

Is it necessary or justifiable for a drainage district to spend money each year in clearing plant growth from the ditches? This is a question which drainage commissioners are sure to ask, particularly if the amount of cultivated land along the ditches is small. Where such growth flourishes the cause is to be found usually in the fact that the channel sections are too large and so do not operate at maximum efficiency. In general, plant growth tends to reduce the potential discharge capacity, but where the flow is never very large it is a question whether the usefulness of the ditch for drainage is impaired seriously by such growth, provided there is sufficient depth. At times of freshets the plants lie flat and the water passes over them. From a sanitary standpoint, however, there is no doubt that plant growth should be removed each year, as there is more or less stagnant water which breeds mosquitos and thus causes malaria.

Sand bars in front of the outlets to field ditches are not caused to a large extent by caving of the waste banks, but by materials brought from far up in the fields at times of heavy rains. Probably the only method to prevent this deposition is to build sand traps in the field ditches a short distance back from their outlets. These would need to be of considerable size and might be made by deepening the ditch for a distance of about 100 ft. and protecting the bank by piling. They would need to be cleaned out after every heavy rain. The prevention of sand deposit from the field ditches is an important phase of maintenance work and one difficult to control. In the Jacob Swamp ditch the sand bars form even when the canal is clear of growth, the velocity of the water not being sufficient to carry off the sand. Sand bars, therefore, require attention at least once each year.

For maintenance of ditches in similar districts the following suggestions are offered: The banks of new ditches seem to become stable after they have passed through three growing seasons. Then plant growth, trees, logs and other débris should be removed from the channel, while the banks should be shrubbed and low-water channels opened through the sand bars. After that the plant growth should be removed from the channel about once in every three or five years. The growth during such a period should not seriously impair the drainage efficiency of the canal, and the cost would not be materially greater than that of removing one year's growth. The banks should be gone over each year and kept shrubbed as far back as the waste bank. Also all logs, trees, stumps, as well as woody growth like willows, should be removed annually from the channel, and low-water channels should be opened through the sand bars.

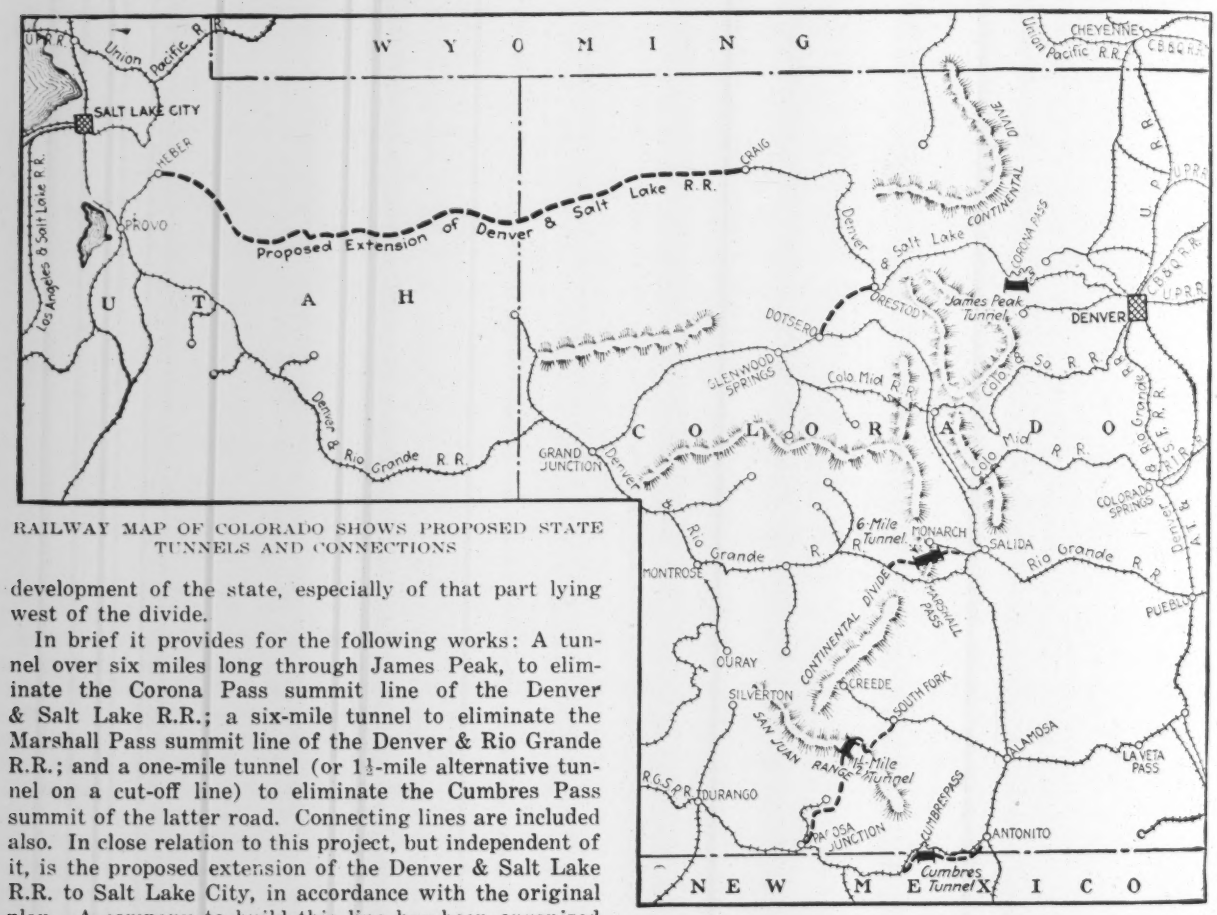
Report on Pollution of the Charles River

By direction of the Massachusetts Legislature the Department of Health of that State has submitted a report upon the sanitary condition of the Charles River above the Charles River dam. The finding is that the river is badly polluted in its upper reaches by sewage and manufacturing wastes from Milford and other towns; that there are objectionable sources of pollution in Newton, Wellesley and Waltham; and that the worst pollution is due to the occasional overflow of storm or combined sewers in Boston and Cambridge. The State Department of Health submits a draft of an act authorizing the Department to prohibit the discharge of sewage into any part of the Charles River or its tributaries. The report contains data regarding existing sources of pollution within various towns and municipalities, together with a number of analyses, some of the latter covering a series of years. Dr. Eugene R. Kelley is commissioner and X. H. Goodnough is chief engineer of the Massachusetts State Department of Health.

State of Colorado Proposes Three Railway Tunnels

Piercing Continental Divide To Increase Traffic Capacities—Finance Project by Bond Issue — Engineers' Report

ONE of the most ambitious railway projects now in view is the proposed construction of three long railway tunnels—aggregating nearly 14 miles—through the continental divide, to be financed by a bond issue of the State of Colorado. Its object is to reduce grades and lower summit elevations and by increasing capacity and service to promote the agricultural and commercial development of the state, especially of that part lying west of the divide.



RAILWAY MAP OF COLORADO SHOWS PROPOSED STATE TUNNELS AND CONNECTIONS

In brief it provides for the following works: A tunnel over six miles long through James Peak, to eliminate the Corona Pass summit line of the Denver & Salt Lake R.R.; a six-mile tunnel to eliminate the Marshall Pass summit line of the Denver & Rio Grande R.R.; and a one-mile tunnel (or 1½-mile alternative tunnel on a cut-off line) to eliminate the Cumbres Pass summit of the latter road. Connecting lines are included also. In close relation to this project, but independent of it, is the proposed extension of the Denver & Salt Lake R.R. to Salt Lake City, in accordance with the original plan. A company to build this line has been organized in Utah with the backing of Governor Bamberger. These proposed works are shown on the accompanying map.

According to the State Railroad Commission in its first report to the Governor, heavy grades and high elevations on all the railways crossing the continental divide in Colorado result in making transportation so slow and expensive that much traffic follows easier lines north and south of that state. The commission, which was appointed to investigate means of improving these conditions, advocates piercing the main range by the three tunnels mentioned. The maximum grades on the main east and west routes would be then only 2 per cent instead of 3 to 4 per cent, as at present. It is held that the cost even at this time will not be excessive and that construction should be begun at once and pushed vigorously to completion. A four-year period is considered sufficient for the longer tunnels.

Public credit of the state must be employed to finance this great project, in the opinion of the Commission, as conditions make it improbable that either private financing or Federal aid can be obtained at this time. It is recommended, therefore, that construction be undertaken by the state, after securing "enforceable contracts" from the railways for their use of the tunnels on terms remunerative to the state. While it is true that these railways are in the hands of receivers, it is considered that receivers' certificates might be issued. The advantages of the tunnels to the railways as well as to the community are such that terms can be made which will pay interest on the cost and provide a sinking fund to retire the bonds within a reasonable period.

As a first step the commission recommends that an amendment to the state constitution be submitted to public vote at the next general election, authorizing the commission to build the tunnels and providing for a bond issue to defray the cost. The act of 1918, under which this commission was appointed, provided for such a vote on a constitutional amendment to authorize an issue of 30-year 4½-per cent bonds to pay for the condemnation of the Denver & Salt Lake R.R. and for the construction and equipment of a tunnel under James Peak for the use of this railway. The present recommendation is based upon an opinion from counsel of the commission, to the effect that this act gives authority to initiate other amendments for smilar purposes.

In the report of L. D. Blauvelt, consulting engineer to the commission, it is pointed out that three separate sections of the state, west of the divide, would benefit by the three tunnels and their railway connections. This western portion is served now by four railway lines, two of which are of narrow gage. All have grades of 3 per cent and over, while three have grades of 4 per cent. No summit elevation is less than 10,000 ft. and the highest is 11,660 ft. above sea level. Climatic conditions at these altitudes are the cause of delay and expense in transportation, but these conditions would be eliminated by the tunnels at elevations of 9,100 to 9,500 ft.

Estimates of cost are not given, since further engineering investigations are necessary. Mr. Blauvelt states it as his conclusion, however, that if the construction is undertaken now, for completion within about 3½ years, "the cost would not be excessive as compared with what it would have been five years ago." No difficult obstacles are foreseen and the locations are adjacent to railways affording transportation for labor, plant and supplies. Machinery and powder are manufactured in Colorado, the latter being one of the largest items in the cost of tunnel construction. It is suggested in his report that the heavy expense frequently incidental to government construction may be avoided if the work is let by contract, after advertising widely for bids. Under this plan, the railways could make bids and thus guarantee themselves against excessive cost.

Particulars of the three tunnel routes as given below are abstracted from Mr. Blauvelt's report.

JAMES PEAK TUNNEL: D. & S. L. R.R.

In addition to improving through transportation the James Peak tunnel would benefit the northwest section of the state west of the divide. The Denver & Salt Lake R.R., which was intended to form a link in a transcontinental system, was planned originally with limits of 2 per cent for grades and 10 degrees for curves, with a low summit elevation in a long tunnel through the divide. Pending the construction of this tunnel an open line was carried over the divide by 4 per cent grades and 16-degree curves, with a summit elevation of 11,660 ft. in the Corona Pass. This open line has practically reached the limit of its traffic capacity.

Extensive surveys for a low-level tunnel to improve operating conditions have been made at different times, resulting in a location for a tunnel 6.4 miles long at an elevation of 9,100 ft., which is said to be the lowest summit elevation practicable directly west of Denver and for many miles north or south of the railway. This tunnel would eliminate all the 4 per cent grades and 16-degree curves, whiel it would save 23½ miles in distance, 8,000 degrees of curvature and 2,500 ft. of rise and fall. It would keep the railway well below the timber line and avoid severe snow conditions.

As an auxiliary project, Mr. Blauvelt proposes a 42-mile connection between the Denver & Salt Lake R.R. at Orestod and the main line of the Denver & Rio Grande R.R. at Dotsero. This connection shown on the map, would give a direct line of 169 miles from Dotsero to Denver, with a saving of 174 miles as compared with 343 miles by the present route. The map shows also the projected extension of the Denver & Salt Lake R.R. for 254 miles from its present terminus at Craig, Colo., to Heber, Utah, where it would connect with an existing 70-mile line to Salt Lake City. The distance from Denver to Craig is 254 miles, or 230 miles by the tunnel, making a direct line of 554 miles (by the tunnel) between Denver and Salt Lake City.

Two lines of the Denver & Rio Grande R. R. serve the middle-western section of Colorado west of the divide. One of these is the main standard-gage line between Denver and Salt Lake City, while the other is the narrow-gage line extending from Salida to Grand Junction, both of which are points on the main line. This narrow-gage route, with 4 per cent. grades and sharp curves, crosses the divide at Marshall Pass, at an elevation of 10,680 ft. Grade reduction and double tracking over the pass have been proposed at different times to facilitate traffic on this route.

The proposed tunnel is on a new connecting line utilizing the Monarch branch, as shown by the map. It would be at an elevation of 9,500 ft., with a length of not more than six miles. This tunnel and connection would give maximum grades of 2 per cent and curves of 10 degrees, instead of 4 per cent grades and 25-degree curves, while it would save 1,300 ft. of rise and fall and avoid the serious snow conditions of operating over Marshall Pass.

CUMBRES TUNNEL: D. & R. G. R.R.

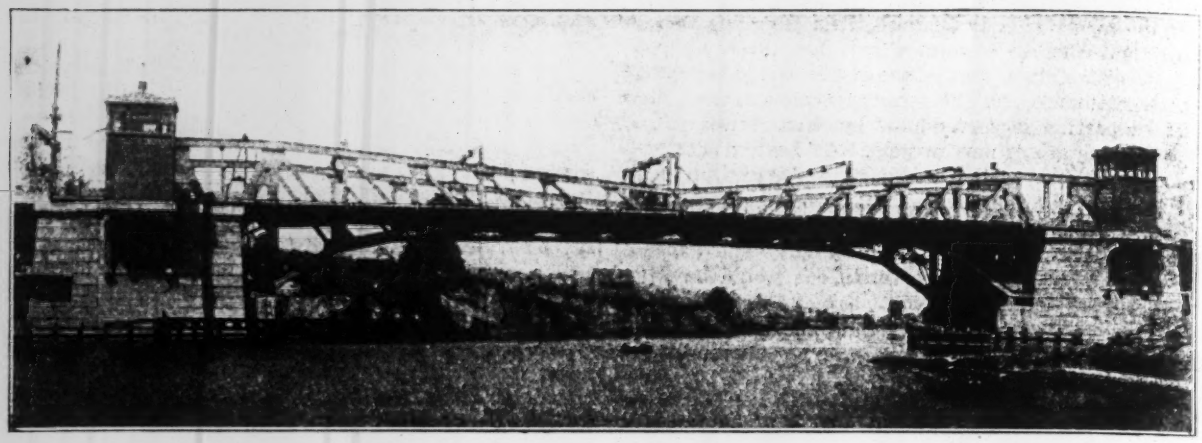
Transportation in the southwestern section of Colorado, west of the divide, together with the adjacent northern part of New Mexico, is dependent upon a line of the Denver & Rio Grande R. R. This is standard gage from Denver to Antonito, thence narrow gage over the divide to Durango and Silverton, with a standard-gage branch south from Durango. The narrow-gage Rio Grande Southern R.R. serves the country northwest of Durango. The present narrow-gage line over the divide, with grades of 4 per cent and curves of 20 degrees, reaches an elevation of 10,015 ft. at the Cumbres Pass. The tunnel would be about a mile long and its connections would have maximum grades of 2 per cent, except for about 24 miles of 2½ and 3 per cent grades approaching the La Veta Pass. In connection with this work the line between Antonito and Durango would be changed to standard gage.

An alternative tunnel location is on a proposed connection from South Fork, on the standard-gage Creede branch, to Pagosa Junction on the narrow-gage line to Durango. This would avoid the Cumbres Pass and would require a tunnel about 1½ miles long. Further investigations are necessary to determine the relative construction cost and operating advantages.

Use of these mountain tunnels for automobile traffic has been suggested, the highway system being extended to the tunnel portals where provision would be made for loading the automobiles on flat cars for passage through the tunnel.

Testing Wear Resistance of Sole Leather

An accelerated-wear test machine for sole leather developed by the Bureau of Standards, in which 12 samples on the periphery of a 15-in. wheel grind against the face of a carborundum disk and turn it against the resistance of a brake, yields in one day a result corresponding to 40 miles of walking. Comparative tests described in Technologic Paper No. 147, just issued, show that service (walking) results are closely paralleled by those obtained with the machine. They also confirm what has been known from experience, that the parts of the hide near the backbone and over the kidneys have highest wear-resistance.



Three Double-Leaf Bascule Bridges at Seattle, Wash.

Spans Have Live-Load Bearings Beyond the Trunnions—Main Pinions Engage Concave Racks—Trusses Assembled Short—Erected in Horizontal Position

By F. A. Rapp
City Bridge Engineer, Seattle, Wash.

THREE bascule highway bridges built across the Puget Sound and Lake Washington Canal by the City of Seattle, Wash., embody a special arrangement of the supports at the trunnion piers by which the counterweight is made to do double duty, and a saving in material is realized. The bridges, which are two-leaf structures of simple trunnion type, have a live-load bearing near the river edge of each trunnion pier, 13 ft. in front of the trunnion, and in closed position each leaf pivots on this bearing instead of on the trunnion. As a result, the counterweight acts with longer lever-arm than it does in the open position of the bridge, and the uplift at the tail of the leaf is much decreased. This arrangement and certain other matters of engineering importance in the design and construction of the three bridges are dealt with in the present article. Conditions stiuplated by the U. S. Government in assuming a share of the cost of the canal controlled the general proportions of the bridges. It was required that the structures should be of a permanent character and should give a clear channel width of 200 ft. with a clearance height of 30 ft. above the lake level for a width of 150 ft. Their spans are 218 to 242 ft. and the clearance heights are greater than that specified; the height from water line to curb is 37 ft. for the bridge at Fremont Ave. and 52 ft. for those at 15th Ave. N. W. and Eastlake Ave. This enables small craft to pass and minimizes the opening of bridges.

Figs. 1 and 3 show the design of the Eastlake Ave. bridge, while the photo above shows the completed bridge at Fremont Ave.

Double-leaf trunnion bascules were adopted, following the general design developed in 1898 by the Chicago Department of Public Works, under John Ericson as city engineer, for the city's bridges over the Chicago River (see *Engineering News* of Jan. 31, 1901, p. 76, and Jan. 19, 1905, p. 65.) They are of half-through type, with trusses having horizontal top chords and curved bottom chords. Each carries a double-track street railway. The canal is crossed at angles of 57° to 66°. At Fremont Ave. the span is 242 ft. between centers of trunnions and the leaves are cantilevered 108 ft. beyond supports on the piers, while the tail

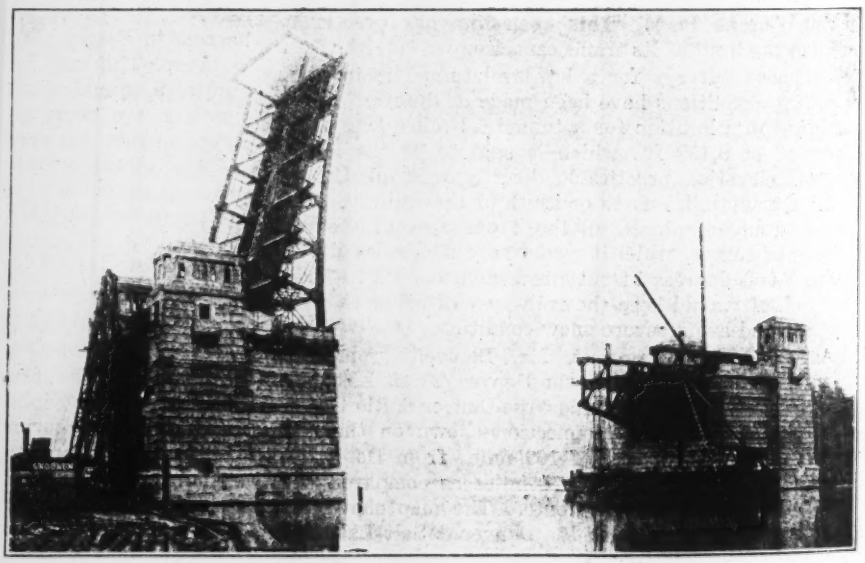


FIG. 1. ERECTION OF 218-FT. BASCULE BRIDGE OVER LAKE WASHINGTON CANAL AT EASTLAKE AVE., SEATTLE, WASH.
(Leaves are erected in horizontal position)

length, from trunnions to anchor brackets, is 38½ ft. A depth of 13 ft. is required for the counterweight pits. In the Eastlake Ave. and 15th Ave. bridges, the span is 218 ft. and the leaves are cantilevered 96 ft., while owing to the greater height and shorter span there are no counterweight pits.

Support of the leaves on live-load bearings in advance

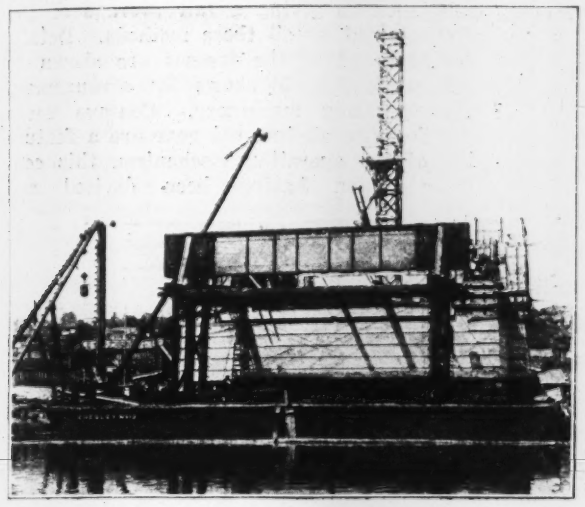


FIG. 2. TRUNNION GIRDER IS SKIDDED ONTO PIER FROM FALSEWORK ON BARGE

of the trunnions reduces the live-load heel uplift and the live-load stresses in the tail. It may be explained that the dead-load stresses, with the bridge in its closed position, are computed on the assumption that the bridge is balanced on the trunnions, while the combined dead- and live-load stresses are figured on the assumption that the bridge is pivoted on the forward or live-load supports. This gives, for dead and live load combined, an anchor arm 13 ft. longer than for dead load only, and thereby makes a portion of the weight of the counterweight effective in anchoring the live load. To accomplish this result a small opening, depending on the stiffness of the anchor arm, is left between the anchor-arm bumper and the anchorage when the bridge is seated on the forward supports. The amount of this opening was determined by experiment and in these bridges is ⅛ in.

The trunnion bearings of each leaf are mounted on a heavy transverse box girder which is supported directly by a pair of masonry piers, instead of being carried by longitudinal girders extending from the channel pier to the anchor pier, as in some of the Chicago bridges. Fig. 2 shows one of these cross-girders being set in place. The live-load uplift of the anchor arm is taken directly by a steel column embedded in a pier at each truss. A description of the piers and foundations of the Eastlake Ave. bridge will be given in a later issue.

A single longitudinal footing on each side of the bridge, at each end, carries the anchor pier and the trunnion pier, as well as the extension of the latter which forms a support for the bottom chord when the bridge is closed, as noted above. To equalize the toe and heel pressures, the footings are trapezoidal in plan, with the wider end at the trunnion pier. The footings are designed for dead plus live load. The dead load on the footings is practically uniform and the maximum pressure is about six thousand pounds per square foot.

The live-load assumption for the floor system provides, on each track, a 60-ton street car with 50-ton trailer, each 47½ ft. long and having two trucks of 6-ft. wheelbase spaced 33½ ft. c. to c. For the roadway, the load is a 24-ton motor truck having a 7 x 16-ft. wheelbase with 15 tons on the rear axle, or as alternative a load of 100 lb. per square foot. Any combination or position of the above loads that would give maximum stresses was used to determine the sections. A wind load, not increased for impact, of 450 lb. per lineal foot of bridge is distributed as 150 lb. each on the upper chord, the lower chord and the floor, these loads being considered as moving. With the bridge open, it is designed to resist a wind load of 15 lb. per square foot acting in any direction.

To provide for impact, the live-load stresses are increased 50 per cent on floorbeams and 60 per cent on stringers, except that at stringers and floorbeams adjacent to the breaks in the floor the increase is 100 per cent. The specifications provided originally for the application of the formula recommended by a committee of the American Railway Engineering Associa-

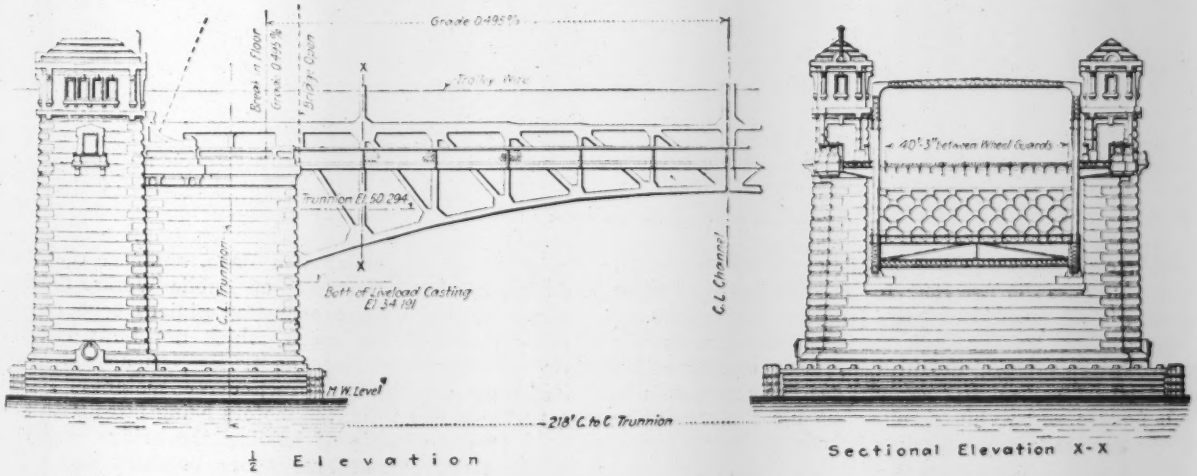


FIG. 3. GENERAL DESIGN OF EASTLAKE AVE. BRIDGE AND PIERS, SEATTLE, WASH.

tion in 1910, except for the modification of taking only half the result, the formula thus modified being

$$I = \frac{100}{1 + \frac{L^2}{20{,}000}} \times 0.5$$

The factor 0.5 was introduced because it was believed that the elimination of unbalanced driving wheels and the reduced speed of electric cars would reduce the impact by this amount. A. Munster, of Seattle, was consulted as the maximum stresses were obtained by full live load on the bridge a flat allowance was proper, and that such a dense loading eliminated much of the element of speed of application of the load. The sizes of floor-beams, stringers and certain truss members were then computed, using the city's impact allowance, Mr. Munster's recommendations and those of three other sets of specifications, the final impact allowances arrived at being considered as giving a fair average of the results obtained by all these methods. Details of the heel end of the trusses are shown in Fig. 4, while Fig. 5 shows the arrangement of the operating machinery. Concave racks forming an internal gear are a feature of the operating mechanism, this construction having been devised and

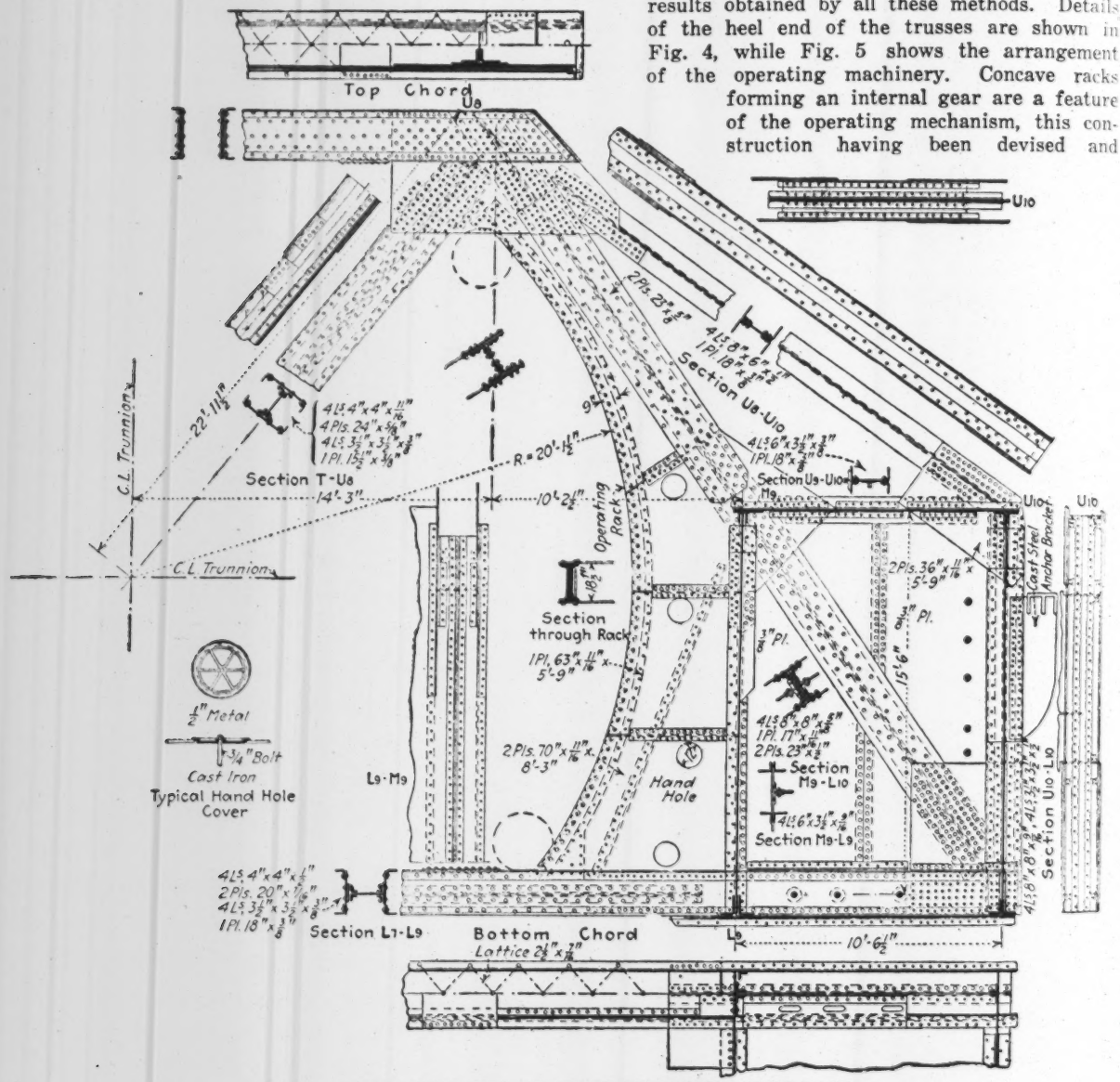


FIG. 4. DETAILS OF HEEL OF TRUSS, WITH OPERATING RACK

and recommended an impact allowance of 70 per cent for stringers, 50 per cent for floor beams and 15 per cent for all members of the trusses. His conclusions were based on the American Railway Engineering Association's tests, modified to meet electric-railway and truck traffic. His report gave the arguments but no figures except his results, but his figures for the floor system corresponded quite closely to the results of the modified formula.

In respect to the trusses, Mr. Munster reasoned that patented by Alexander Von Babo, engineer of bridge design in the Department of Public Works, Chicago. The gear trains drive operating pinions engaging the inner faces of the racks, which are built into the counterweight arms of the trusses, as shown. Each leaf is operated by two direct-current motors of 100-hp. capacity at 550 volts, the motors being fitted with solenoid brakes capable of holding the bridge against a 15-lb. wind. Hand brakes are provided also. One operator controls both leaves.

An emergency hand operating connection, with four-arm capstan operated from the deck of the approach, can open the bridge in six hours. This is not an unusual period for hand operation of a bridge of this size and weight, but such provision is made against complete failure of the power apparatus that the necessity of using the hand operating mechanism is extremely remote. Each leaf can be operated independently and either of its two motors is powerful enough to operate it. In addition, a set of spare parts for one motor and solenoid brake is kept at each bridge. During construction it was found that the six-hour period for hand operations could be reduced to two hours by attaching a small automobile to the arm and running it around.

The machinery is designed to hold the bridge against a wind pressure of 15 lb. per square foot on the surface of the floor of the moving leaf to operate in a 10-lb wind pressure without exceeding working stresses as follows: From 20,000 lb. to 5,000 lb. for tooth speeds of 100 to 1,800 ft. per minute at 15 lb.; from 15,000 to 3,750 lb. for the same tooth speeds at 10-lb. pressure. All gears are of cast steel, with machine-cut teeth of 20° involute pattern, except that the racks have molded teeth. The main pinions are of forged steel with teeth cut from the solid.

For the operation of the center locks, shown in Fig. 7, there is a line shaft extending across the bridge and driven by a 3¾-hp. motor at one end. Experience shows, however, the advisability of placing the motor or turning mechanism at the middle of the shaft, so as to eliminate any tendency of one lock pin to lag relative to the other. It is found that the lock pin at the far end of the shaft lags ⅜ in. behind the pin at the motor end, with no extraordinary resistance to overcome. If the rebound of a careless landing puts the leaves in bad alignment the lag is greater.

It has happened that the twisting of the shaft was enough to interfere with the electrical contact that indicates by a light in the operator's house that the center locks are thrown, and at the same time releases power to the hoisting motors. This contact is made with an arm fastened to the shaft, and any angular deflection is multiplied at the contact at the extremity of the arm. This difficulty was obviated by putting the contactor at the end of the shaft next the motor. In addition to the center lock pins, a set of rail locks was originally operated by this shaft, but it was found necessary to disconnect the rail locks permanently. If the motor was in the middle of the shaft the deflection at the ends of the shaft would be reduced one-half and the rail locks would be operated with a very short length of shaft.

A bank of signal lights shows the operator the positions of the leaves while they are moving. The mechanism consists simply of a revolving drum switch with a number of contacts on its surface wired to lamps in a slate board mounted in front of the operator, the lamps being set for definite positions in the angular movement of the leaf. The drum is geared to the main trunnion, so that the contacts on the drum are made or broken as the bridge moves, and the lights are switched in or out correspondingly.

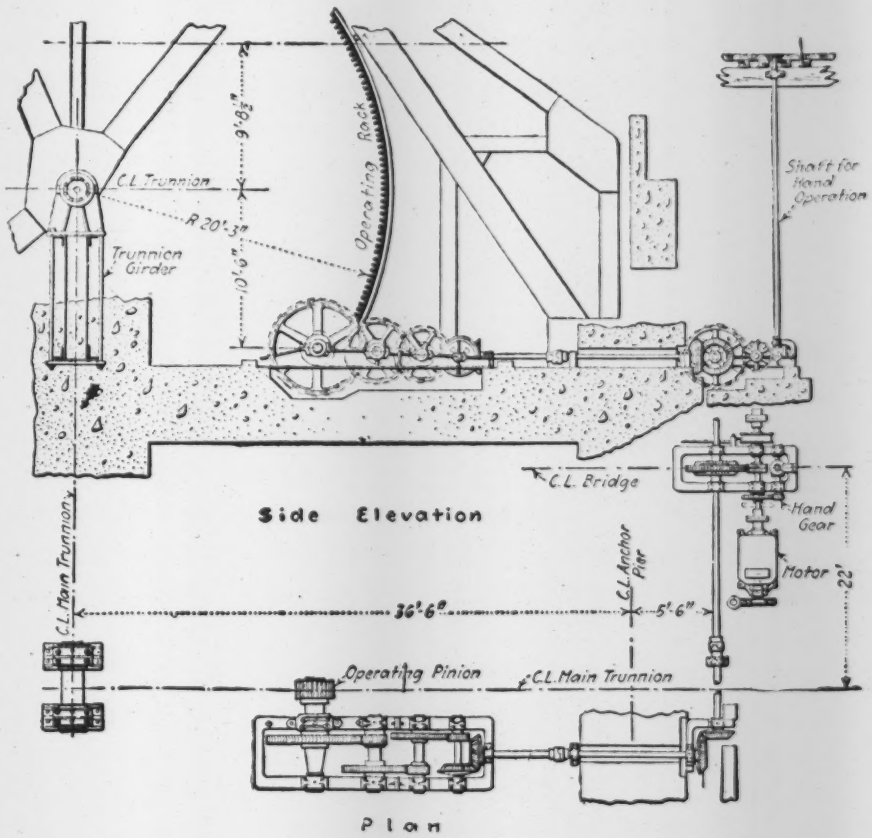


FIG. 5. OPERATING MACHINERY HAS PINIONS ENGAGING CONCAVE RACKS

Swinging gate arms and an audible signal are placed at both approaches, but in spite of the latter the gates are occasionally smashed by speeding automobiles.

The counterweights are composed of a mixture of gravel concrete and cinder concrete filled into steel boxes built into the rear of the trusses, below the deck. Two pockets aggregating about 3 per cent of the volume of the box are formed in the concrete, to provide for cast blocks used in adjusting the weight for wet and dry seasons. To insure the proper position of the center of gravity of the counterweight, all the sand and gravel was passed over a platform scale on its way to the mixer. Each day the position of the center of gravity was computed, and any variation from the designed position corrected by varying the mixture.

Creosoted fir blocks 3¼ in. thick for the roadway paving of the leaves are laid on a deck composed of a bottom layer of 4-in. transverse planks and an upper layer of 2-in. longitudinal planks, covered with two

layers of one-ply roofing felt mopped in place with tar. Each block was dipped about one-fourth its depth in hot asphalt and when pushed into place was toenailed with an 8-penny wire nail. At intervals of eight rows transverse angles 1½ x 1½ x ⅜ in. were screwed to the deck to prevent shifting of the blocks due to the operation of the bridge. Hot asphalt was spread with squeegees to fill the joints for half their depth, and hot sand filled in to the surface.

All truss connections were assembled and reamed at the shop. The operating racks also were assembled, and holes then drilled in the solid for the turned bolts, which have a light driving fit. All gears and shafting were mounted in their frames at the shop and there operated to insure accurate assembly.

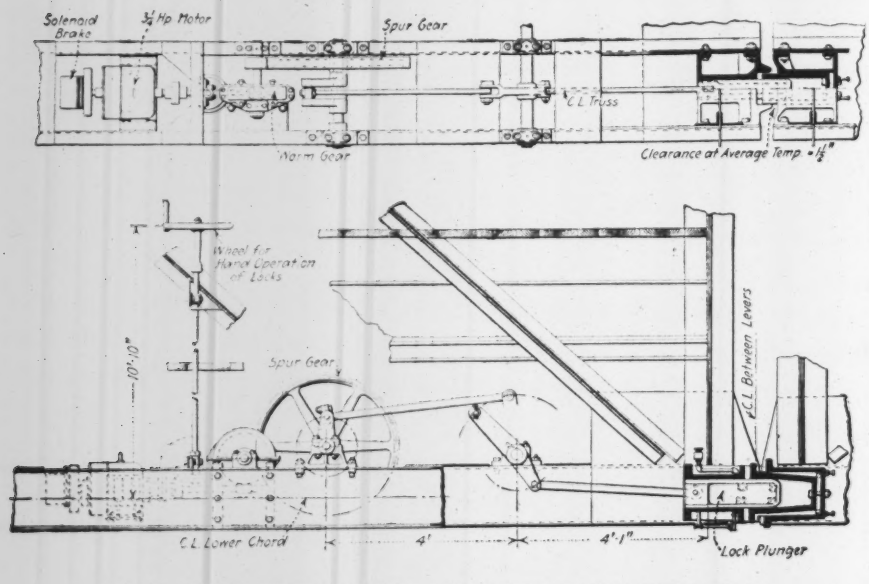


FIG. 6. MOTOR-OPERATED END LOCKS FOR BASCULE BRIDGES

Erection was done with the leaves in horizontal position, blocked against the anchorage. One leaf was completed and raised to the vertical position before starting the opposite leaf, thus leaving at least half the channel width unobstructed. This method of erection is the most natural and economical where shipping can get along with the restricted opening, and these bridges provide so much vertical clearance that a large proportion of traffic passes under them. With the bridge in the closed position and blocked against the anchorage there is no necessity for keeping the bridge balanced by adding counterweight as the erection proceeds, the counterweight being poured in finally in a continuous operation, thus securing better results. The handling of the steel is more economically done by this method, as it avoids the increasing lift and consequent raising of the derrick as the work proceeds.

On the Eastlake Ave. bridge the procedure was as follows: The main cross-girders for the trunnion bearings were brought to the site on a barge, this barge having falsework of such height that the girder could be skidded into place on the piers, as shown in Fig. 4. After this, the platform of the fixed parts was raised by a ginpole footed on the foundation cofferdam. A large guyed derrick was then set up on this platform and handled the heavy members of the anchor arm and counterweight box. The cantilever arms were erected by a stiff-leg derrick which moved out on the floor system as the erection proceeded, the pieces being taken from a barge beneath. The heaviest parts were about 50 tons in weight and 54 ft. long.

The heavy cross-girders were loaded on the barges at the Smith Cove terminal of the Port of Seattle Commission, by means of a 50-ton crane with a reach over a railway track at the edge of the wharf. The rest of the material was lightered from the railway terminal to a storage yard near the bridge site. One difficulty experienced was that the trusses assembled ¾ in. to 1 in. short in each leaf, thus leaving a wider central gap than had been intended and making it necessary to set the center locks at their full limit. There was trouble also with the bearing plates on top of the main cross-girders under the trunnion bearings, which were planed on a bevel to counteract the deflection of the girders, so that the bore of the bearings would be level. The shortness of the trusses was due to the shopwork. A careful survey showed each panel of the overhanging arm to be short from ⅛ in. to ¼ in., while the panel between the forward pier support and the trunnions was short ⅜ in. in one truss, but as yet no explanation has been obtained from the fabricators.

Two of the bridges were commenced in 1915 and completed in 1917. For the one at Fifteenth Ave. N. W., there were 1,104 tons of structural steel and 118 tons of machinery; the cost was $109,862 for the substructure and $141,605 for the superstructure. The Fremont Ave. bridge required 1,176 tons of structural steel and 132 tons of machinery; its cost was $114,773 for the substructure and $161,017 for the superstructure. The Eastlake Ave. bridge was delayed by failure of the first contractor for the substructure and was not completed until April, 1919. Its cost was $233,877 for the substructure and $192,220 for the superstructure, this increase over the other bridges being due largely to piling and concrete foundation and to reletting portions of the work at wartime prices.

Under the direction of A. H. Dimock, city engineer, design and erection of these bridges were in charge of the writer, as city bridge engineer, while the architectural treatment of the piers was designed by D. R. Huntington, city architect. The city's superintendents of construction were J. Charles Rathbun for the bridge at Fifteenth Ave. N. W., J. A. Dunford for the Fremont Ave. bridge, and E. K. Triol for the Eastlake Ave. bridge. The contractors were as follows, all being of Seattle: Fifteenth Ave. N. W., substructure and superstructure, Hans Pederson; Fremont Ave., substructure, Pacific States Construction Co.; superstructure, United States Steel Products Co., Eastlake Ave.; substructure, Booker, Kiehl & Whipple; superstructure, United States Steel Products Co.

Studying the Effect of Impact and Wear on Road Surfaces

HAVING obtained data on the impact exerted by motor trucks, the Bureau of Public Roads is now studying the effect of impact on different types of road pavement. The earlier tests were described in *Engineering News-Record*, Sept. 18, 1919, p. 573. The new tests are not yet completed, but it is the hope of the bureau that they will furnish data of value to the highway designer.

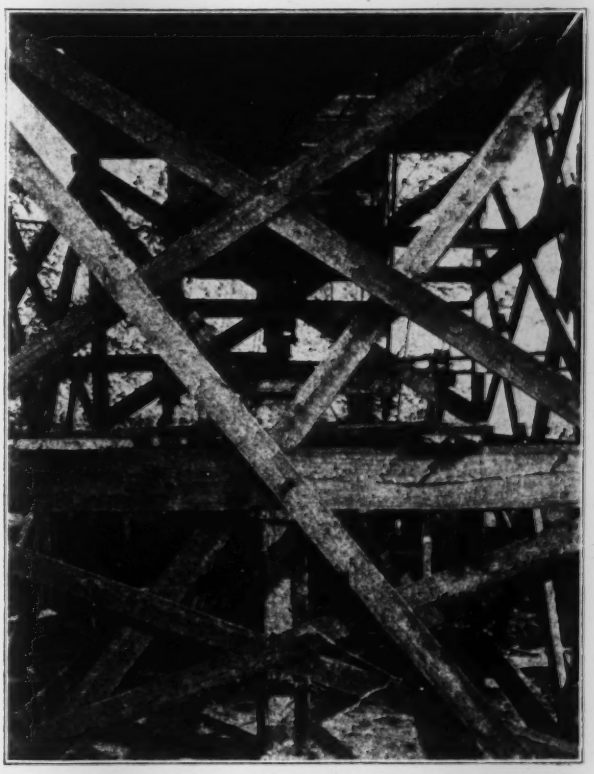
Two different classes of tests are being carried on: direct determination of impact effect and (2) comparative resistance to wear of varying types of surfaces on different types of bases.

For the first class of tests a number of slabs, 7 ft. square, have been laid directly on the subgrade. Half of these sections have been laid upon a subgrade that is purposely kept wet and the others are upon well drained subgrade. Sections thus far constructed include concrete in depths varying from 2 to 10 in. and brick constructed on varying thicknesses of concrete bases. Various kinds of brick have been used, including repressed wire-cut lug and vertical-fibre brick. Monolithic, semi-monolithic and sand cushion construction have been used and portland cement grout and bituminous mastic fillers have been employed. In other sections the brick have been laid directly on the subgrade and in others on a prepared macadam base.

Slabs are tested by means of an impact machine designed to represent the conditions existing on the rear wheel of a truck. This machine has an unsprung weight of 3,000 lb. and will carry a sprung weight of 9,000 lb., weights which correspond approximately to those existing on the rear wheel of a 7½-ton truck. The lower end of the sprung weight is shoed with a solid rubber tire and the whole weight is raised to such a height that, when allowed to fall, the impact delivered will be one that might be delivered by a 7½-ton truck. Observations will consist in noting the behavior of slabs when subjected to repeated impacts of the machine, and in measuring deflections of the surface. A cam, driven by a gasoline motor mounted on a scaffold, allows, with the aid of a walking beam, the sprung weight to deliver repeated blows to the road surface.

The tests are being carried on under the supervision of A. T. Goldbeck, engineer of tests, Bureau of Public Roads, though the actual tests are being made by E. T. Smith and J. T. Pauls. Regarding the tests Mr. Goldbeck has this to say:

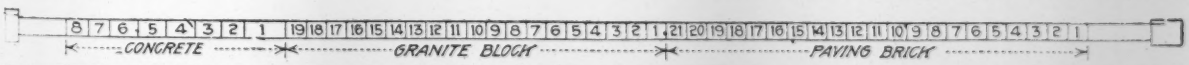
"With the completion of these tests it is hoped that



MACHINE FOR TESTING IMPACT ON ROAD SLABS

sufficient data will have been accumulated to place the design of roads on a much sounder basis than at present, and it is hoped that the results combined with the results of still other investigations will finally lead to a method suitable for determining with certainty road types and cross sections for definite subgrade and load conditions."

When these tests have been completed it is planned



Sec. No.	Aggregate Kind	Aggregate Size	Section Thick	Section Length	Section Laid
1	Trap Rock	2"-¾"	6"	16.5	8-6
2	Limestone	¾"-2½"	6"	9.0'	8-6
3	Sandstone	¾"-2½"	6"	10.5'	8-6
4	Gravel	¾"-1½"	6"	11.2'	8-6
5	Slag	¾"-2½"	6"	11.1'	8-7
6	Gravel	¾"-1½"	6"	12.0'	8-7
7	Slag	¾"-2½"	6"	7.2'	8-7
8	Gneiss	¾"-1¼"	6"	12.5'	8-7

KEY

W.C.L. = 4" Wire cut lug Brick
V.F. = 4" Vertical Fiber Brick
Rep. = 4" Repressed Brick
3"W.C.L. = 3" Wire cut lug Brick
S = Sand
S.C. = Sand Cement Cushion, Dry Mix.
R. = Screening Cushion
A. = Asphalt Filler
C.S. = Grout Filler
Mac. = Macadam
C = Cement
K = Concrete
T.S. = Tar Mastic
T = Tar
A.S. = Asphalt Mastic

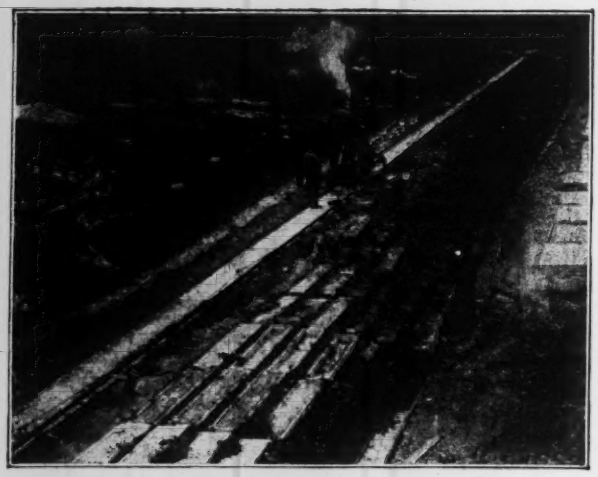
Sec. No.	Granite Block Source	Cushion Material	Cushion Thick	Section Length	Section Laid	Joint Filler Material	Joint Filler Poured
1	Vinal Haven (Leopold)	S.C. 4:1	1"	8'	7-16	C.S. 1:1	7-16
2	Rockport	S.C. 4:1	1"	8'	7-16	C.S. 1:1	7-16
3	Mt. Airy	S.C. 4:1	1"	8'	7-16	C.S. 1:1	7-16
4	Chelmsford	S.C. 4:1	1"	8'	7-16	C.S. 1:1	7-16
5	Concord (Swenson)	S.C. 4:1	1"	8'	7-16	C.S. 1:1	7-16
6	Cape Anne	S.C. 4:1	1"	8'	7-16	C.S. 1:1	7-16
7	Lithonia	S.C. 4:1	1"	8'	8-25	C.S. 1:1	8-25
8	Lithonia	S.C. 4:1	1"	8'	8-25	A	8-25
9	Vinal Haven (Leopold)	S.C. 4:1	1"	8'	7-17	A	7-17
10	Rockport	S.C. 4:1	1"	8'	7-17	A	7-17
11	Mt. Airy	S.C. 4:1	1"	8'	7-17	A	7-17
12	Vinal Haven (Booth)	S.C. 4:1	1"	8'	7-17	A.S.	7-17
13	Chelmsford	S.C. 4:1	1"	8'	7-17	A.S.	7-17
14	Concord (N.E.Gr.)	S.C. 4:1	1"	8'	7-17	A.S.	7-17
15	Somes Sound	S.	1"	8'	7-17	A	7-17
16	Long Cove	A.S.	1"	8'	7-17	A.S.	7-17
17	Vinal Haven (Booth)	S.C. 4:1	1"	8'	8-25	T.S.	8-25
18	Somes Sound	S.	1"	8'	8-25	T	8-25
19	Long Cove	T.S.	1"	8'	8-25	T.S.	8-25

Sec. No.	Brick Type	Brick % Wear	Cushion Material	Cushion Thick	Section Length	Section Laid	Joint Filler Material	Joint Filler Laid
1	Rep.	16	S.C. 4:1	1"	8'	7-5	C.S. 1:1	7-5
2	W.C.L.	16	S.C. 4:1	1"	8'	7-7	C.S. 1:1	7-7
3	Rep.	19	S.C. 4:1	1"	8'	7-7	C.S. 1:1	7-7
4	W.C.L.	19	S.C. 4:1	1"	8'	7-7	C.S. 1:1	7-7
5	Rep.	24	S.C. 4:1	1"	8'	7-7	C.S. 1:1	7-7
6	W.C.L.	24	S.C. 4:1	1"	8'	7-7	C.S. 1:1	7-7
7	Rep.	16	S.C. 4:1	1"	8'	7-8	A	8-25
8	W.C.L.	16	S.C. 4:1	1"	8'	7-8	A	8-25
9	Rep.	19	S.C. 4:1	1"	8'	7-8	A	8-25
10	W.C.L.	19	S.C. 4:1	1"	8'	7-8	A	8-25
11	Rep.	24	S.C. 4:1	1"	8'	7-8	A	8-25
12	W.C.L.	24	S.C. 4:1	1"	8'	7-8	A	8-25
13	V.F.	18.8	S.C. 4:1	1"	8'	7-9	A	8-25
14	V.F.	18.8	S	1"	8'	7-9	A	8-25
15	3"W.C.L.	17.7	S	1"	8'	7-9	A	8-25
16	3"W.C.L.	17.7	S	1"	8'	7-9	A.S. 1:1	8-25
17	3"W.C.L.	17.7	S	1"	8'	7-11	T	7-14
18	3"W.C.L.	17.7	S	1"	8'	7-11	T.S. 1:1	7-14
19	3"W.C.L.	17.7	S	1"	8'	7-11	C.S. 1:1	7-14
20	W.C.L.	16	S	1"	8'	7-11	T	7-14
21	V.F.	18.8	S.C. 4:1	1"	8'	7-11	C.S. 1:1	7-14

PLAN OF RUNWAY, AND DATA CONCERNING THE CONSTRUCTION OF EACH OF 19 TEST SECTIONS

to carry on similar ones upon bituminous surfaces laid on concrete bases using a 1:3:6 as well as a 1:1½:3 mixture. In addition broken stone will be used under bituminous surfaces.

The other tests are being made with the aid of a pavement-wear test machine designed and built in the Bureau of Public Roads. It consists essentially of five cast-iron wheels each 48 in. in diameter and 2 in. wide and weighing 1,000 lb. mounted inside of a structural steel frame so as to operate independently



PAVEMENT WEARING TEST MACHINE OPERATING OVER 400-FT. RUNWAY

of each other. The frame itself is mounted upon trucks and the whole is operated over a 30-in. gage track, being propelled backward and forward by an endless cable and automatic reversing grips. The rails are supported on 6-in. x 30-in. reinforced-concrete curbs, between which are laid the various test sections of road. This test strip is 400 ft. in length and 24 in. wide and contains 49 different types of pavement, divided into three main groups—vitrified paving brick, granite block and portland cement concrete. The machine travels at approximately 5 miles per hour.

All block sections are laid upon an 8-in. 1:3:6 concrete base which in turn rests upon 18 in. of compacted cinder fill. Every effort was made in the laying of these various test specimens to secure as perfect drainage as possible so that whatever disintegration occurs will be due either to the wear or breaking up of the surface of the pavement and not to any failure of the foundation.

The test machine to date has made approximately 1,000 trips and considerable wear is reported on several of the sections. Although the wheels roll up and down the roadway in exactly the same path and the action is thereby greatly accelerated, it is considered that the resulting conditions approximate very fairly what would result from the action of steel-tired city traffic, which was the desired end when the machine was constructed.

Combined Asbestos and Cement Pipe Made in Italy

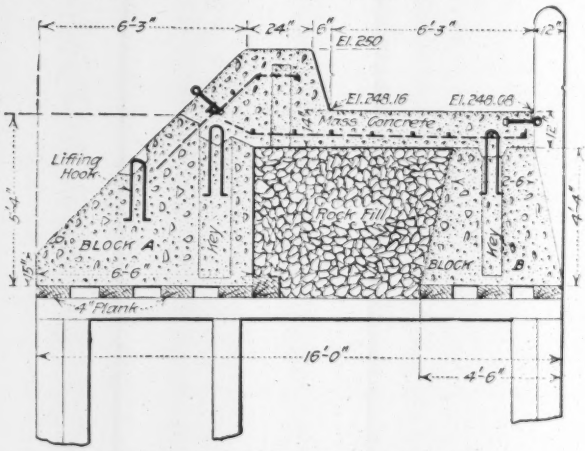
An asbestos shingle company, in Italy, has recently begun the manufacture of pipe made of 85 per cent portland cement and 15 per cent asbestos fibre of shingle stock grade. The pipe is made 4 to 12 in. in diameter, varying in thickness from ½ to ⅝ in. respectively.

Progress on Toronto Harbor Works

Although New Works Lagged During War They Are Now Going Ahead—Use Shows Value of Proposed Development

SEVEN years ago work was started on an ambitious harbor scheme for the City of Toronto, Ont., with an estimated total cost of about $20,000,000, and an expectation of completion in 1920. Just as the work was well under way the great war came and slowed down all construction and raised all costs. As a result it is probable that the cost will run much higher than the estimate, while it is certain that the work cannot be completed this year. Nevertheless, much was done before the war, and some little during the war, particularly such as was necessary to provide for war factories on reclaimed land. During last summer the construction was again speeded up, so that today the development has made sufficient progress to make it worth recording.

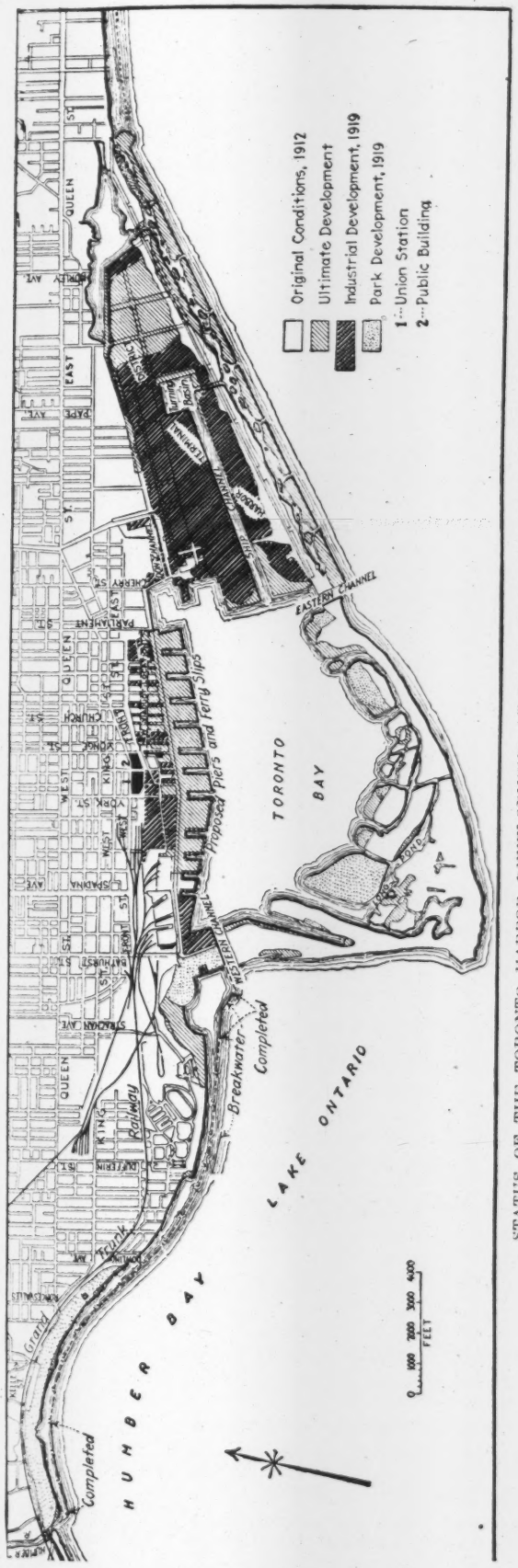
The waterfront of the center part of the City of Toronto is protected from Lake Ontario by a natural island curving crescent-shape in front of the shore. The development proposed in 1912 was divided into three parts. To the west of this island the lake front was to be protected by a paralleling breakwater and the shore developed, mainly for park, amusement and resi-



DETAILS OF BREAKWATER AT WEST END OF HARBOR

dential purposes. The bay front is that section of the city facing the waters inclosed by the island, and was to be developed in wide piers and intervening slips, with industrial plants on the piers. The island itself was to be filled in, in certain places, with dredgings from the bay, which was to be excavated to give a depth of 30 ft. Probably the most important part of this development is the reclamation of the land between the island front and the city at the west part of the city. Here was originally a marshy area known as Ashbridge's Bay. This is to be filled in and developed for industrial purposes with a ship channel 400 ft. wide leading to a 1100-ft. square turning basin in the center of the district. Boulevards were to be continued around the island from one part of the city to the other, and the west end of the island is separated from the lake by small lagoons in such fashion as to make it available for summer residences.

The accompanying map indicates the condition of the progress at the end of last season. At the western



STATUS OF THE TORONTO HARBOR DEVELOPMENT AT THE END OF WORKING SEASON, 1919

section of the work the shore line, outside of the tracks of the Grand Trunk Ry., has been reclaimed practically to the full extent of the original intention, and the protecting breakwater started at the far western end. It is the intention in the coming season to spend a considerable part of the current appropriation in the further development of this section by building dancing pavilions, bathing beaches and restaurants, all to be conducted under the direction of the Toronto Harbor Commissioners. The breakwater is being built by the Federal Government. It is made up of reinforced-concrete precast blocks resting on a timber pile and timber cap support, shown in the detail herewith. In that detail block A and block B are precast, and are set on the timber base, to be filled in between with a rock fill and capped with a mass concrete top as shown. At the eastern end of the western section there still remains a small area to be reclaimed.

In the central section, the beginnings of the pier and slip development show. Just inside the western channel, across which a proposed bascule bridge has not yet been built, is an extensive area reclaimed during the war and utilized as a shipyard for the Canadian Shipbuilding Co., Ltd. Extending east from this plant the bulkhead wall is now being continued to the foot of York St. The construction at this point consists of precast blocks on a timber frame, somewhat similar to the breakwater design, with a dredged fill pumped in behind to form the new land.

It is the intention in this section to develop a marginal street at Queens Quay, with a warehouse and factory construction on the ground between the slips. The development hinges a good deal upon a new viaduct which will carry the tracks of all the railroads into the city across the streets entering the harbor industrial development here. At present these tracks spread at the old union station and pass along parallel to the present shore line on grade. A new union station is about completed, fronting on Front St. and between York St. and Bay St., and according to an agreement made five years ago between the railways concerned, the city, and the Toronto Harbor Commissioners, a new viaduct will carry all the tracks over these entering streets from the union station east to Parliament St. An effort is now being made by the railways to have the agreement changed, but it is thought that neither the city nor the Harbor Commissioners will agree to this.

It is also the intention to bring along the marginal street the lines of the so-called "radial" interurban electric lines which are to be built by the Province of Ontario, so as to form along the waterfront, between York St. and Yonge St., a transportation center for out-of-town traffic. Practically all the urban railway lines deliver their passengers farther uptown, so that it is thought there will not be any congestion by delivering the out-of-town interurban and steam railway passengers here. As soon as the viaduct carrying the through tracks of the steam lines is built, spur lines on grade will be brought in from west and east to the center slip to serve the warehouses between the various slips. These lines will not cross the two center piers of the development but will be stub-ended, leaving an open space to permit the free surface travel to the two center piers, which will probably be utilized for lake ships and ferry lines to the island, which latter carry very heavy traffic in the summer.

In the eastern part of the development, work is progressing very favorably. The so-called Don channel, which carries the Don River out into Toronto Bay, has been completed by the building of a concrete wall along both sides, and is now utilized for industrial development, with a bascule bridge at the foot of Cherry St. The ship channel farther out in the old Ashbridge's Bay district is completed, and work is proceeding on the walls forming the turning basin. These walls are similar in construction to the breakwater, except that they are of mass concrete on timber frames based on wood piles and with a sheet-pile facing wall, and tied back to anchor piles. Filling is going on in the area from hydraulic dredging in the main bay. During the war a large area was utilized here for the British Forgings, Ltd., where various war materials were manufactured. This represents the largest utilization of the hitherto unused ground in the whole development. Five years ago, where the British Forgings, Ltd., plant was built was part marsh and part water. Now it is a flourishing plant, connected by tracks to the main rail system. While the plant is of no further use for the purpose for which it was built, it is being taken over by English steel interests and will be further enlarged at an early date. Leases have also been written for a considerable part of the remaining reclaimed ground, so the commissioners feel very hopeful of the future prosperity of the scheme.

Nothing has been done toward the boulevard drive location or in the development of the lake side of the island, though as shown on the map some little work has been done in reclaiming land on the bay side.

All the work is under the direction of the Toronto Harbor Commission, of which E. L. Cousins is chief engineer and manager. The commission is made up of five members, three of whom are appointed by the city, one is the representative of the Dominion Government and one is appointed by the Government on the nomination of the Toronto Board of Trade. The city, the Dominion and the commission share the cost. Articles describing the original plans for the development appeared in *Engineering News* of May 24, 1913, p. 1115, and *Engineering Record* of Sept. 19, 1914, p. 326.

For the coming season the Dominion Government has appropriated $1,500,000 which will nearly complete the west breakwater and the commission will spend about $4,000,000 in extending the central pier district, completing the turning basin and in providing recreational facilities at the west end.

A Ferry-Boat Swing Bridge

On narrow, navigable streams with small tidal variation in Harris County, Texas, a flatboat, similar to the ferry boats used in that district, is made to serve as a swing bridge. The boa, with aprons at each end raised or lowered by a winch, reaches between either timber or concrete bulkheads built at each bank of the stream. A boat 60 ft. long, with an 11-ft. apron at each end, was completed early in September. It is of ordinary flatboat construction, 10 ft. in width. The boat is anchored by cables. When it is necessary to allow river traffic to pass, the bridge is swung up or down stream according to the direction of the tide, and subsequently pulled back into place. Howe Wise, Houston, Tex., are highway engineers for Harris County.

Notes from Foreign Fields

Through the Panama Canal

BY S. T. HENRY

An American engineer locking through the Panama Canal for the first time will more than likely get these general impressions:

1. The Canal is a much bigger project than it usually is visualized from descriptions in the technical press.
2. The job has been well done, from every angle.
3. The slides are still a serious problem, and are likely to continue to cause trouble for a long time. There is an evident confidence everywhere in the Zone, however, that the slides are licked and that they will rarely, if ever again, seriously hamper the passage of ships.
4. All operations appear to synchronize perfectly.
5. The volume of traffic is much heavier than is generally sensed from statistics.
6. Every American engineer should visit the Canal for the inspiration that he is sure to get from a week or ten days in the Zone.

There are, of course, other impressions that will come to different engineers according to the breadth and depth of their technical training and experience. But the general impressions mentioned appeared to be the consensus of the opinions of a group of engineers from the States who recently made their initial passage through the Canal en route to South America.

Our ship came in sight of the irregular mountainous Panamanian shore late in the afternoon, six days out from New York. Shortly afterward we could see the superstructure of the great Colon coaling station, then the two long breakwaters that make such a wonderful harbor of Limon Bay. In passing through the entrance to the harbor between the breakwaters one is impressed with the similarity to the entrance to the harbors at Milwaukee and Cleveland. The background is, of course, entirely different.

We pulled alongside the coaling dock early in the evening to refill our fuel oil tanks. Although this required only four hours, we could not get away until daybreak, because the night operation of the Canal has not yet been undertaken. Everything is in readiness for operating at night. It has been deemed inadvisable, however, to attempt this until necessary.

At Colon the predominant feature is the coaling station. It is so tremendous that no description of it can give an adequate idea. Talks with officers of ships that bring the fuel to the station and of ships which refuel there frequently bore out the evident efficiency of the entire plant.

A few hours in a launch around Limon Bay, afoot and in the inevitable one-horse shays in Colon and Cristobal are filled with much of consuming interest. One is struck especially with the great concrete wharves and warehouses. Ships of all flags were loading and unloading. With the present traffic through the Canal, Colon has already become one of the world's great cargo transfer points.

Leaving Colon at daybreak, our ship backed out into the harbor and headed into the canal. The first stretch

is a wide, straight cut through low swampy ground. The flight of three locks at Gatun loom up in the distance immediately.

Arriving at the approach to the first lock our ship was quickly under the control of the electric touring locomotives. With three locomotives on each side, one just ahead, one amidships and one just aft, the ship moved forward slowly with every evidence of the capacity of the locomotives to meet emergencies. Then the great gates swung into place, the water began to boil up in astonishing volume from the numerous inlets. The lock was filled and the ship lifted 32 ft. in about 9 minutes. Then the gates ahead swung open and we moved forward into the next lock.

And so on through that lock and the third lock. No one seemed to hurry, there was no shouting, everything seemed to operate just right at the right time. Every man evidently knew his job and did it without haste or concern. It was teamwork to a fine degree.

At the same time, one got the feeling that every move was so absolutely under control that a slip anywhere would be caught and checked instantly. And then there were all the safety and emergency gates if real trouble came. But one felt that serious trouble could scarcely occur.

As the ship rose in the third lock Gatun Dam lay to the right—a long, low middle west ridge in the midst of the irregular volcanic hills of the vicinity. In the near distance was the Gatun Spillway and just below in the roof of the power house where the energy to operate the canal is generated. Before us lay Gatun Lake. How much greater expanse it covers than one had expected! What a tremendous volume of water it must contain! The statistics have told us all this over and over again. But there was the lake itself, and it seemed so much bigger than dry figures ever could have enabled us to realize.

Thousands of times the questions have arisen: What would happen if an accident swept away the lock gates? What if the dam gave way? They would arise naturally in one's mind if he had never heard of the Canal before. But, at the same time, one gets from what he can merely see a confidence that such emergencies scarcely can happen.

Our ship steamed out, as all ships do, and sailed away at a fair pace on this huge man-made lake 85 ft. above the sea. The course through the lake appeared more tortuous than had been expected. But the wide, easy turns seemed to offer no handicap to our progress. We were soon through the lake and entering the cut section.

Any engineer who has studied the Canal only from descriptions in the technical press, cannot suppress a thrill as he approaches Culebra Cut. It is interesting to pass through the locks and the lake—but the Cut! During the construction it came to be the controlling feature of the job, at least in the minds of outside engineers. Now it appears to them to be the one big problem that is still in process of solution. The men who have been on the job may feel that this or that or another feature of the project is of greater importance. The casual observer will hold, however, to his impressions of the Cut.

As the ship approached the Cut there were the slides. They are bigger and more vicious looking than any one in the party, who knew only ordinary construction job troubles, had expected. The materials that are moving are a very much mixed-up mess. The slides also appear to have moved in various cross currents to the main movement. They appear likely to continue to move irregularly. But as the ship went slowly between them there came to all of us who had seen the slides for the first time a conviction that the channel could be kept open, regardless of what happened. On the other hand, they apparently will be taking out material in large quantities for a long time to come.

When the Cut was passed, with its dredges at work and in reserve, the Pedro Miguel locks were soon reached. By this time most of the party were authorities on lock operation. We knew just what was going to happen and where it was going to happen. But a child can safely state that the hands of the clock will turn a certain way.

Passage through the Pedro Miguel lock, the Miraflores basin and the Miraflores locks took too little time to get more than a passing glance at the work which had been done there so thoroughly and so well. What could be seen heightened the impressions of the bigness of the job and the perfect synchronizing of the operation.

Beyond the last lock at Miraflores is a short stretch of straight channel cut through low swampy ground. At the end of this is the small harbor at Balboa. Here we were surprised to see an old German vessel of 8,000 to 9,000 tons being completely overhauled and refitted. Several others vessels also were undergoing repairs. When the shipyard whistle blew at quitting time, there were the same crowds of workmen pouring out that are to be seen at various shipyards along both our Coasts. And as we moved along there was the big dry dock hidden behind the yard buildings, but looming up with the masts of a ship just visible over its rim.

Now we headed out into the Pacific. In about seven hours we had gone through the Canal from ocean to ocean. We had seen a big job well done. We had seen an example of a wonderful organization handling a big operating problem smoothly, and without evidence of strain, or friction, or undue haste.

Every American engineer may well be proud of the Canal. It is an American job done by American engineers in American fashion. Probably there were mistakes here and there in the design. Probably there were mistakes here and there in the execution. Probably the operation could be improved. But the Canal is working smoothly and satisfactorily. It is giving to the world all the advantages it was expected to secure for commerce and for civilization generally. These things have been said so often that one hesitates to repeat them. But few American engineers have grasped what the Canal is and what it means to the United States and to the world.

Every American engineer who has a real pride in his profession can get so much from a trip to the Canal that he should plan the next vacation there. And a trip to Panama fits in well for engineers. December and January are the best months to go. That also is the time when most engineers can best take their vacations. It is a good time to be away from our northern states. The weather along the Canal is not unpleasant. then. The sea voyage down and back and the experience in the Canal will make an ideal vacation.

Impressions Here and There

Middle West Member Attends Am. Soc. C. E. Meeting in New York

NOT having had the opportunity of attending a regular meeting of the American Society of Civil Engineers for 10 years a member from the Middle West naturally looked forward with pleasure to resuming the practice. The occasion was the highway meeting of March 17, referred to afterward as "one of the best in some months." Frankly the experience was not up to expectations.

Most of the technical societies of the Middle and Far West have either undergone in 10 years a change for the better in the matter of program-building that is decidedly noticeable, or else they have gone out of existence. There are extremely few of the latter class. Rather has there been a revivification and assumption of grave responsibility to members that is hard to believe unless one has maintained constant touch with them. Sometimes the changes have been gradual, as with the Iowa and Michigan State organizations, and again it has been rapid, as with the city societies, at Cleveland and Kansas City.

How, then, has the national society developed? Would a comparison with the Western Society of Engineers made ten years ago still hold? J. H. Warder, the secretary of the latter, was then in his prime and kept things moving. No one went to sleep at meetings. At least three people would introduce themselves to you and the experience usually proved so exhilarating that you easily got into the habit yourself, without apparent loss of modesty. Programs were studied beforehand. Those which were on timely topics and would produce the greatest amount of discussion were preferred. Since then many changes have taken place in the W. S. E. Controversies have taken place over its alleged non-progressiveness. Its shortcomings have been dissected, diagnosed and rightly or wrongly prescribed for. Early in this 10-year period it voted to have its meetings on Monday, because the majority wanted them on that night rather than on Wednesday, which psychologists argue is the most likely of any night in the week to draw a crowd. Meetings begin at 7 sharp and stop at 9 sharp. No one goes home after work, so why squander any more time for supper? An engineer's wife appreciates his getting home early and some attention must be paid to her opinion if the society expects to claim full attendance of the younger married men, who need its advantages most. Always the program committee has kept in mind, at least sub-consciously, that participants in the discussion at least will have had a "pleasant and valuable" evening and therefore the more members of the audience express themselves the more successful will the meeting be. The same thing holds true of community singing and it is utilized to advantage in more than one society of the Middle West.

Now, to go back to the A. S. C. E. meeting. It was a surprise to find that the 1,248 members in District 1 and the few from outside are content to be served with semi-monthly meetings and none in the summer; barely 20 a year. Why own a hall? Renting would be far cheaper. With all the ramifications into which civil engineering has extended, 20 meetings a year would seem scarcely enough to give each branch an evening. A water-works engineer is not interested primarily in the steel framing of a sky scraper, a highway engineer in sewage disposal, nor a reinforced-concrete building expert in railroad transportation problems, which means that the same 150 men do not come to all of the meetings.

The second surprise was an 8:40 p.m. start. Do New Yorkers go home for dinner? They do not work long after 5 p.m., and a 2-hour cafe dinner can hardly be indulged in at present prices. Perhaps a dozen men were in the reading room at 8. Distances are long, but transportation is excellent in New York. Thirty minutes will carry one far. Why, then, the late start?

With a background of several years' experience in program building the writer was anxious to observe how the program for this meeting was put together and how it would work out. The subject was "The Nation-Wide Demand for Improved Highways." One had a right to expect from the greatest technical society real constructive help for the most perplexed engineers of our profession today. The highway problem is the greatest civil engineering problem, exceeding even that of our railroads.

What did the program propose—and, remember, an 8:40 p.m. start? Four separate subjects, one of which was subdivided into four parts. Program? Yes, enough for a convention. Nearly every topic could and should have been developed and expanded to occupy the major portion of an evening if the discussion of those in the audience were added. Impressions on the presentation of the separate subjects are hardly germane, but think of the incongruity of placing on the same program (beginning at 8:40) a historical review, the relation of highways to railroads, the economics of road building as related to truck haulage and to maintenance and the construction problems of 1920 on which state highway engineers have labored incessantly for six months.

It was 11 p.m. when the program-mill stopped grinding. Discussion was confined to questions. Two were asked. Great is the vitality of the New Yorker. Groups gathered about these speakers who had been so vigorous as to arouse opposing opinions. A genial Uncle Tom served the collation (New Yorkers for "refreshments") while spirited conversation rapidly relieved the pent-up restlessness of the last hour. One requires energy, and plenty of it, to make new acquaintances at 11 p.m. Infliction of fagged brain on old friends seemed out of place; in consequence an early departure was inevitable.

An observer of audiences soon finds that 40 min. is as long as the average individual can retain interest in a given subject at a meeting. Why then expect any discussion? From 8:40 to 11 is 3½ times 40 min. and an audience of engineers is not that many times more enduring as to receptivity than the average gathering.

Arranging a program is no sinecure and these impressions are written not without knowledge of the task. Few constructive criticisms, or destructive for that matter, ever reached committees on which the writer has served, but he has often thought of the value they would have been had the reaction of even a small portion of the audience been available 12 or 24 hours after the meeting. That's why this is written.

MIDDLE WEST.

Hudson Vehicle Tunnel Discussed By Gen. Goethals

Traffic Capacity and Structural Design in the Light of Criticisms of the Concrete-Block Plan by the Tunnel Commission's Engineers—Calculations of Shell Strength Compared With Practice

Replying to sharp criticisms directed at the concrete-block plan for the Hudson River vehicle tunnel, Gen. George W. Goethals makes an instructive contribution to the literature of subaqueous tunneling in a memorandum addressed to the joint tunnel commissions of New York and New Jersey under date of April 2, 1920. He reasserts and upholds his recommendations of three years ago in favor of a tunnel accommodating three lines of traffic in each direction, and defends the choice of a 22½-ft. roadway width for three-line service. To provide greater freedom of movement, however, he suggests that 25-ft. roadways may be preferred, and in that event he would place such roadways in separate tubes. Dealing with the question of tunnel type and strength of shell, he strongly restates his advocacy of concrete-block construction, and gives calculations of strength to justify this position. The calculations made by the commission engineers, quoted in some detail in *Engineering News-Record* of March 25, p. 624, are attacked as fundamentally unsound.

In form, Gen. Goethals' memorandum concerns itself with the five questions addressed by him to the commission on Feb. 18, and the replies thereto made by Clifford M. Holland, chief engineer to the commissions, and Col. William J. Wilgus, chairman of the board of advisory engineers. These questions and the replies were cited in the reference given above (p. 624). Introducing his discussion, however, he gives a clear statement of his attitude toward trench-method tunnel construction for the present enterprise, and of the genesis of the 42-ft. concrete-block "Goethals plan" tunnel.

Trench Tunnel Construction

Prior to 1917 the tunnel commissions of New York and New Jersey had been giving close study to the problem of constructing a tunnel for vehicular traffic between the cities of New York and Jersey City. Certain engineers had reported advocating two single-way cast-iron-ring tunnels, similar in type to the existing Pennsylvania R.R. tubes. Other engineers had reported advocating reinforced-concrete tunnels constructed in sections on shore, floated and sunk to place below the bed of the North River in a deep trench excavated for this purpose.

In 1917 I was requested by the commission to examine the different plans proposed for the vehicular tunnel and make a definite recommendation. A thorough study of the proposed plans and all physical data which had been gathered was made. It seemed obvious that whatever type of tunnel was to be adopted, it should of necessity have greater cross-sectional dimensions than had been heretofore constructed. The reinforced-concrete type, laid under cut-and-cover conditions, most readily met this fundamental requirement of size and would, in all probability, be the least costly, provided the character of the river bed was such as to make reasonably practical the cutting and maintaining of the deep trench from shore to shore.

Very careful study was given to the character of the bottom of the river at the proposed location. This was possible in great detail, not only from borings and soundings which had been made, but from the published and printed records of the actual construction conditions in the Pennsylvania R.R. and McAdoo tunnels. This was further supplemented by conferences with some of the men who were in actual charge under the river of these tunnels during their construction. The result of these studies convinced me, having in mind previous experience with similar material, that it would be exceedingly doubtful if such a trench could be maintained except at an enormous expense, and consequently I was reluctantly compelled to decide against this type of construction and passed to the study of the most economical and feasible types of driven tunnels.

Shield-Driven Tunnel Preferred

Tunnels of this latter type had been constructed using both cast-iron lining and precast concrete blocks. Under the North River the cast iron had been used exclusively, except in the case of the 2,000-ft. portion in the north Christopher McAdoo tunnel, which had been built of brick in the early eighties without the use of the shield.

The feasibility of constructing cast-iron-lined tunnels 30 ft. in diameter and upwards I considered possible even though such size had not been actually attempted before. An investigation of the probable cost of such a type at once disclosed the very great cost for material, due to war prices for cast iron then prevailing. Further, at the time it was highly problematical whether the iron could be obtained when needed, having in mind the uncertainty of the length of duration of the war.

Economy of Concrete-Block Shell

A preliminary study of tunnel costs, using precast concrete blocks in place of cast iron for the tunnel ring, immediately disclosed the great saving in cost that would be effected if that type of construction was feasible for the North River conditions. At this point I took the matter up with the head of a firm of contracting engineers who had done more actual tunnel work in the North and East Rivers than any other concern, covering years of experience. I found him an advocate of the block tunnel for the North River, based on his experience with block tunnels of smaller diameters, his experience in the North River and the methods of driving which he had adopted as a result of such experience.

The closest study was given to these details, and stress analysis were made of different-size tunnels with concrete-block rings. As a result of this work and studies of design, I recommended the 36 ft. inside diameter tunnel with two levels, each having a roadway with 24 ft. 6 in. clear width between walls, or 22 ft. 6 in. between curbs.

From this point are discussed the five or more specific statements of your commission [see *Engineering News-Record*, March 25, 1920, p. 624.—Editor] which form the basis of your decision to the effect that the block type of tunnel is impractical to build, structurally defective and unsuited generally for the purpose intended.

Capacity and Roadway Width

Previous to my report of Nov. 24, 1917, there was no advocacy as far as I was aware of the desirability and necessity of providing for more than two lines of traffic in each direction. In fact, provision for single-line traffic only was being strongly urged by certain engineers.

Studies of volume, character and yearly increase of the vehicular traffic using North River ferries and East River bridges seemed to present some basis for estimating future traffic through the proposed tunnel. I decided, however, that to follow such a basis blindly would not take into consideration an increment beyond the apparent normal yearly increase under existing conditions. The yearly increasing congestion at the ferries throttles the development that would otherwise result were facilities for crossing the river made simpler and easier, as would obtain through tunnel crossings. To ignore this fact in laying out a project of this character would result in the same mistakes which have been made year after year in engineering matters dealing with the transportation of the public in Manhattan and vicinity, in that the structures would be taxed to their capacity almost at once upon their completion and going into service.

I accordingly decided that a vehicular tunnel providing for less than three lines of traffic would be a mistake. It

then remained to decide the minimum width of roadway on which three lines of miscellaneous types of vehicles could travel and at the same time confine the extreme dimensions of the tunnel within practicable construction limits.

This was worked out on a basis of 24 ft. 6 in. clear distance between walls and 22 ft. 6 in. between curbs. Such widths would permit one line of trucks on one side and two parallel lines of pleasure vehicles having maximum width of 6 ft., leaving 14 in. clearance between vehicles. Probably 90 per cent of the traffic would have greater clearance than this, as the dimensions used above are maximum.

Arrangement of Three Lines of Traffic

It was not considered necessary to provide space for two lines of trucks of maximum width moving abreast, with a pleasure car of maximum width alongside. The period of time during which the two trucks of maximum size were abreast would be that required for one truck to pass ahead of one directly in front.

For conditions, therefore, of maximum service in the tunnel, there would result a series of cars moving three abreast and others moving two abreast. The question of maximum capacity of the tunnel then becomes one of average speed and average distance between cars. Under actual operating conditions, traffic in a tunnel of this road width would move in two streams, with cars constantly swinging out and passing ahead into line. For this service, road widths of 22 ft. 6 in. and 23 ft. provide sufficient room at speeds to be permitted. To say that such a roadway is not a three-line road and can only be estimated on the basis of a two-line roadway, where there is not room to pass between parallel cars, is erroneous and misleading.

It is obvious that a 24-ft. width of roadway will give greater traffic capacity, and, notwithstanding loud criticisms heretofore voiced by certain engineers against the unnecessarily large capacity of the 22 ft. 6 in. roadway, I am now of the opinion that your commission may well consider the advisability of increasing to 25 ft. If such a width was adopted, the roadways should be placed in two single tunnels constructed of concrete blocks. Studies and estimates of such size tunnels have been made.

Structural Strength

In approaching the analysis of stresses in a tunnel to be driven through the Hudson River material, first there should be taken into consideration the method to be followed in opening the hole within which is to be placed the tunnel structure. If a hole is to be opened which is larger than the structure to be placed within it, the loadings that will be brought to bear upon the structure during construction will be different from those which will result if the structure to be built entirely fills the hole continuously and supports the surrounding material.

Effect of Void Back of Shield

Under the conditions of the hole being larger than the structure to be built, the surrounding material is left unsupported, and will break up and move in until it comes in contact with the exterior of the structure. Under these conditions we have to consider forces that act against the structure in varying degrees of inclination from the horizontal and in varying intensities. After the material has broken up and moved into contact with the structure throughout its exterior area, then the forces can be computed and the direction of their action approximately known.

In the construction of the Pennsylvania tubes and in the construction of any tube by the shield method, where provision is not made to bring the structure in full contact with the surrounding material before movement, we would have to design the structure to have sufficient strength to resist the forces of unknown magnitude brought to bear upon the structure by reason of the moving in of the surrounding material and its being brought to rest by the structure. The bringing to rest of this material involves a structure having sufficient strength to resist the unknown kinetic energy of the moving material.

Distortion and Breaking of Shell

In the construction of the Pennsylvania tubes of cast iron, the method of construction was such as to permit this breaking up of the surrounding material and its movement through a considerable space into contact with the exterior of the rings. This force distorted the ring, and made it necessary to support the interior by means of vertical timbering or horizontal tension members. Notwithstanding this provision the forces were sufficient to break the cast-iron rings at different times. As the material came to rest around the exterior of the rings, the ring returned approximately to its circular form, indicating forces that act normally to the ring. Pressure readings of these forces, taken over a period of eight months when applied to the analysis of the ring, bear out the assumptions that these forces do act normally to the ring.

If then a tunnel can be built which completely fills the excavated hole, so that the material is not allowed to move inward, you would have the approximate condition that existed in the Pennsylvania tubes after construction, as indicated by the recorded pressure readings.

Load on Tunnel Shell

The assumptions used in analyzing the block tunnel by your engineers are based on a theory that assumes the material to be perfectly fluid, except as influenced by the friction of the individual particles of the material, and ignores the existence of cohesion; in other words, a perfectly granular material. These assumptions applied to a block tunnel for a material having a stiffness expressed by an angle of repose of 13° leads to results that indicate the unsafeness and structural defectiveness of the block tunnel. If, however, these same assumptions are used in the analysis of the cast-iron tunnel during construction, either for the existing Pennsylvania tunnels before the interior concrete was placed, or for your engineers' proposed cast-iron tunnel before concrete is placed, the forces are of such magnitude and of such direction that they give an unsafe condition for the cast-iron rings, in that the tension in the cast iron rises upwards of 9,800 lb. per sq.in. This is an unsafe stress for cast iron, and does not allow for an increased tensile stress developed, of unknown magnitude, resulting from the kinetic energy of the material moving through the exterior space until it comes in contact and is brought to rest by the ring.

Preventing Movement of Surrounding Soil

The construction of the proposed concrete-block tunnel involves methods that result in a tunnel being built of the actual outside diameter created by the shield in its travel forward, so that the surrounding material is not allowed to move and is constantly supported as the shield moves forward. The pressure diagrams of the Pennsylvania tubes show the forces such a tunnel has to resist.

In support of the recognition of the existence of cohesion, it may be pointed out that before any readings on the gages could be obtained in the Pennsylvania tubes it was necessary to destroy the cohesion of the material immediately in contact with the ring, by stirring up the material with a bar passed out into the surrounding material. This fact is further borne out by the fact that segments of the tunnels have been removed and the material stands unsupported until broken down by a flow of water destroying its cohesion.

Method of Load Calculation

In analyzing the forces acting on a tunnel built in such a way as to completely fill the annular area immediately in the rear of the tail of the shield, whereby no motion is permitted to be set up in the surrounding material, we take the total weight of the water and the overlying material, consisting of silt and clay, or a combination of both, at the top of the ring. We also assume that the sum of the downward forces must be equal to the sum of the upward forces, provided the tunnel can be proven not to be at the point of floating. The pressures from the top of the tunnel to the bottom of the tunnel increase uniformly with each foot of depth and act approximately normal to the ring. These assumptions, if applied to the existing Pennsylvania tubes, will give pressures following very closely the pressures actually read in these tunnels, and do not diverge from such actually observed pressures by more than 8 per cent to 10 per cent.

During the construction of North and East River tunnels, and prior to 1915, it was the practice to fill the exterior annular space left by the shield tail with grout. This material being a fluid did not prevent slumping of the top and sides of the excavation, so distortion of the cast-iron ring together with broken segments continued to result.

It was not until the methods of forcing fine dry gravel under high pressure into the annular space were perfected that distortion troubles with unsafe stresses were eliminated. The use of this gravel packing is not the result of theorizing, but one of hardheaded practical experience and amply demonstrated as to its effectiveness through continued use by practical tunnel builders.

In very soft overlying material, the continued application of pressure gravel can be used if desired and necessary to actually displace all the overlying material, leaving the tunnel roof in solid gravel. Such a result has actually been obtained in one tunnel under the East River recently built.

Will the Tunnel Float?

Passing to the question of flotation. If you will examine the stress sheets prepared by your engineers, you will find that even under their granular theory, the proposed block tunnel is structurally sound for materials having angles of repose under 6°. They state, however, that in material of 3° angle of repose the concrete-block tunnel would float. Provided the material has no cohesion, it is true theoretically the block tunnel would float as stated by your engineers. But why conveniently apply this condition only to the concrete tunnel? The same reasoning shows that not only would your proposed 29 ft. cast-iron tunnel float during construction, but likewise the existing Pennsylvania R.R. tunnels would have floated.

Disintegration in Joints

Further criticism of the block tunnel has been made on the basis that the proposed construction involves a multiplicity of a great number of small joints, resulting in a tunnel which longitudinally has very little strength and is subject to opening for slight deformations.

The individual voussoir blocks making up the concrete tunnel ring are bolted one to the other throughout the length of the tunnel. These bolts perform the same function as do the bolts used in bolting up the rings of the cast-iron tunnel.

An investigation of the relative strength longitudinally of the block and cast-iron tunnels shows the block type to have greater longitudinal strength and resisting moment than either the 29-ft. cast-iron tunnel or the Pennsylvania R.R. tubes.

Referring again to the criticism of the multiplicity of small joints. You are aware, of course, that approximately 2,000 ft. of the north Christopher St. tunnel of the McAdoo tube system is constructed of brick laid in Rosendale cement mortar, and, although this was built 35 to 40 years ago without the use of a shield, trains are operating through it today.

Summarizing, the above statements as to structural strength may be covered as follow:

i. Theory of granular material, used by your engineers, is incorrectly applied to this material, as shown by: (a) Great amount of cohesion; (b) Absence of large active horizontal forces in material as shown in existing Pennsylvania R.R. tunnels.

ii. We have applied theory based on following assumptions: (a) Vertical pressure at top of tunnel equal to weight of material; (b) Algebraic sum of vertical forces equal to zero; (c) All pressures normal to surface of tunnel; (d) Pressures increase at a rate uniform for each foot of depth (determined for our computations by above assumptions). These assumptions are based on the use of gravel packing back of the shield.

iii. Comparison with pressure readings taken in Pennsylvania tubes shows variation of less than 10 per cent from results of our normal pressure formulas.

iv. Your engineers have applied their assumption of granular material having an angle of repose of 13° to the large two-level block tunnel, and we have checked their figures very closely. We have applied these assumptions to a smaller block tunnel having a single roadway 25 ft. between curbs, to the cast-iron tunnel 29 ft. in diameter recommended by your engineers, and to the Pennsylvania tubes, 23 ft. in outside diameter, cast iron. I believe these assumptions incorrect, but the results are:

	Max. Compression per sq.in.	Max. Tension per sq.in.
42-ft. block tunnel—two level	976 lb.	475 lb.
36½-ft. block tunnel (one 25-ft. roadway)	794 lb.	377 lb.
29-ft. cast-iron tunnel	12,967 lb.	9,846 lb.
23-ft. Pennsylvania tunnel	14,175 lb.	11,430 lb.

v. We have applied our normal pressure formulas as checked by Pennsylvania pressure diagrams to the above; the results are:

	Max. Compression per sq.in.	
42-ft. tunnel	310	No tension
36½-ft. tunnel	270	No tension
29-ft. cast-iron tunnel	1,840	No tension
23-ft. Pennsylvania tubes	1,645	No tension

vi. The presence of cohesion acts in two ways, first in the reduction of active pressures which have been considered in the above formulas; second, in the increase of passive resistance which is not included in our theory. This latter is an added factor of safety, existing only when packing is used.

In order to break, the ring must deform; in order to deform the ring must move against the material at some point; in order to move it must overcome large passive forces.

vii. As to flotation, the following data are at hand, all assuming no cohesion and granular material:

42 -ft. tunnel.....angle of equilibrium, 3° 50′
36½-ft. tunnel.....angle of equilibrium, 3° 12′
Pennsylvania tubes....angle of equilibrium, 3° 14′
29-ft. tunnel.....angle of equilibrium, 4° 00′

That is, the 29-ft. tunnel is the most liable to float of these four tunnels, and all will float in 3° material, if these assumptions of material with no cohesion were correct.

viii. *As to longitudinal strength:* In resistance to tension, the 29-ft. cast-iron tunnel has less than 54 per cent of the strength of the 42-ft. tunnel, and the Pennsylvania tubes less than 32%. In resistance to moment the 29-ft. cast-iron tunnel has less than 38% of the strength of the 42-ft. block tunnel, and the Pennsylvania tubes, less than 18 per cent.

Safety of Tunnels Demonstrated

It is obvious that the question of the safety of the proposed vehicular tunnels, of any design, in so far as the engineering analyses of these tunnels are concerned, is based on the assumptions of how the material acts. Your engineers have taken such assumptions, which applied in a mathematical analysis of the tunnel give results that permit them to state that the block tunnel is unsafe. They very conveniently, however, fail to apply the same assumptions to the cast-iron tunnel. If they had, they would have found these tunnels likewise unsafe, as we have demonstrated above.

The assumptions of loadings which we have used are, in our opinion, more reasonable, sound and correct than those used by your engineers, and fortunately we have actual pressure readings on the present Pennsylvania tubes, which, when applied to the proposed vehicular tunnel, give us practically the same results as the results obtained from the application of our theories of the forces to be brought to bear upon these tunnels. As demonstrated above, these results are conclusive in showing that either the block tunnels as proposed or the cast-iron tunnels, built or proposed, are safe.

SUITABILITY OF CONCRETE FOR THE NORTH RIVER

Your engineers state that the block tunnels cannot be made water-tight and that any resulting leakage will result in disintegration.

All joints between blocks of the concrete tunnel are so designed that they can be readily filled with cement under pressure throughout the area of their faces. To say this tunnel cannot be made water-tight is to ignore the actual accomplishments of the result in tunnels of this character built and building.

Disintegration of concrete in sea water may result when reinforcing steel is placed too close to the surface and when proper and intelligent care is not given to secure concrete of proper mixture. We are not dealing with reinforced concrete in this instance and, further, the precast blocks are most easily moulded with the densest and most uniform materials possible.

Disintegration of concrete may take place through electrolysis in the presence of direct-current circuits when current leakage is not provided against. This condition will not obtain in the vehicular tunnel.

A statement that seepage of water through the ring of the proposed tunnel will disintegrate the concrete and endanger the permanency of the structure under the conditions that will obtain is so fallacious that it should not be given serious consideration. To accept such a statement would be to condemn some of the most important of the world's concrete structures, many of which have been standing for decades.

Estimate of Costs

The estimates of cost of the 36-ft. block tunnel were based on prices of 1917, and on the experience of the O'Rourke Engineering Construction Co. in work of this character.

My communications to the joint commissions on this matter have stated always that the figure of $12,000,000 was exclusive of property and right-of-way. I was not asked or expected to pass on the valuation of property that might be required.

The controversy and criticisms on costs that have been raging from the beginning lead nowhere. Over a year ago I recommended a program to the joint commission under which definite data as to costs could be obtained and immediately thereafter the type of tunnel settled and construction commenced.

Cost Comparison From Bids

My recommendation was to invite definite bids from the three or more large engineering construction concerns experienced in tunnel construction. These bids were to be limited only to tunnels having a certain width of roadway, and for the location Canal St. to 11th St. The type of construction, single or twin tunnels, was to be left open, and the bidder was to be invited to submit *bona fide* bids on concrete block, cast iron and open trench types, and time required to build. The bidder would be required to submit detailed plans on which his bids were based, for which actual cost of preparation would be paid upon rejection. The bids would be based on general specifications only, and the bidder was to be required to furnish ample bonded security to protect the commissions and place full responsibility on the prospective contractor.

With such bids before the commission the question of costs would not be at issue, and it would only remain for the commission's engineers to pass on the desirability of the different plans submitted, taking into consideration all phases of economy and engineering.

This recommendation was not followed, and the vehicular tunnel project is no nearer consummation today than it was a year or more ago, with the further result that costs have unquestionably risen in the meantime.

The estimate of three years was based on the statements of a prospective bidder of experience. Here again the program outlined above if followed would have made unnecessary this part of the controversy.

Conclusions

A vehicular tunnel providing for less than three lines of traffic in each direction, if adopted, I consider would be a mistake in judgment and a lack of vision on the part of those responsible as to future demands of the continued growth of the cities of New York and Jersey.

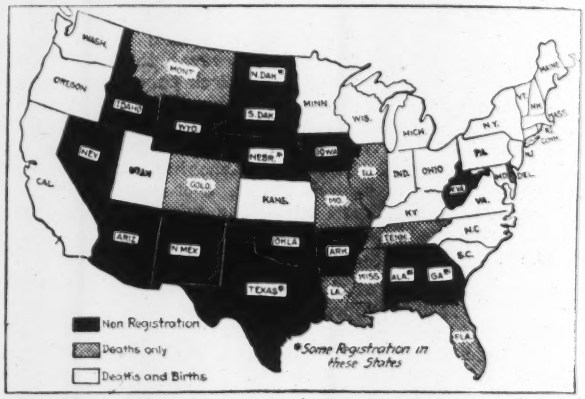
Concrete, as a material, unassisted by cast iron, is preeminently suitable for tunnel construction and the proposed concrete-block type is sound in engineering principle, practicable to build, structurally safe, will not float or sink, and finally is far more economical than cast iron.

The paramount questions still remains: Will your commission, simply because fearful of attempting something which heretofore has not been tried out in its entirety, recommend the expenditure of 26 to 30 millions to create facilities for vehicular crossing of the North River, when 10 to 12 millions less than this amount will accomplish the desired end. Respectfully,

New York, April 2, 1920. GEO. W. GOETHALS.

Birth and Death Registration Areas

THIRTY-THREE States, the District of Columbia and Hawaii were included in the death registration area of the United States on Jan. 1, 1920, and twenty-three States and the District of Columbia were in the birth registration area on that date. The percentages of total estimated population in the two areas were 80.4 in the death area and 58.4 in the birth area. There were also 17 death registration cities in non-registration States on Jan. 1, 1920. Further details are given in the accompanying table and a graphical exhibit for the whole country is shown by a map. It may be explained



SKETCH MAP OF BIRTH AND DEATH REGISTRATION AREAS OF THE UNITED STATES ON JAN. 1, 1920

According to the Division of Vital Sstatistics, Bureau of the Census the non-registration states starred (*) have one or more registration cities, as given in the table.

that the admission of States and cities to the registration area is conditioned on their maintaining a reasonably complete registration of births and deaths. The information here given is based on the records of the Bureau of the Census, a transcript of which was supplied to *Engineering News-Record* on request by Dr. William H. Davis, chief statistician for vital statistics.

THE REGISTRATION AREA OF THE UNITED STATES
DECEMBER 1, 1919

From the Bureau of the Census

State	Year Admitted Death Area	Year Admitted Birth Area	State	Year Admitted Death Area	Year Admitted Birth Area
California	1906	1919	New Jersey	1880	
Colorado	1906	....	New York	1890	1915
Connecticut	1890	1915	North Carolina	1916	1917
Delaware	1919	....	Ohio	1909	1917
Florida	1919	....	Oregon	1918	1919
Illinois	1918	....	Pennsylvania	1906	1915
Indiana	1900	1917	Rhode Island	1890	1915
Kansas	1914	1917	South Carolina	1916	1919
Kentucky	1911	1917	Tennessee	1917	....
Louisiana	1918	....	Utah	1910	1917
Maine	1900	1915	Vermont	1890	1915
Maryland	1906	1916	Virginia	1918	1917
Massachusetts	1880	1915	Washington	1908	1917
Michigan	1900	1915	Wisconsin	1908	1917
Minnesota	1910	1915			
Mississippi	1919	....	Total states	33	24
Missouri	1911	....	District of Columbia	1880	1915
Montana	1910	....	Territory of Hawaii	1917	....
New Hampshire	1890	1915			

CITIES IN NON-REGISTRATION AREA

Alabama: Birmingham, Mobile, Montgomery. *Georgia:* Atlanta, Brunswick and Savannah. *Nebraska:* Lincoln and Omaha. *North Dakota:* Fargo. *Texas:* Beaumont, Cleburne, Dallas, El Paso, Galveston, Houston and San Antonio. *West Virginia:* Wheeling.

Success of Screw Spikes Depends Largely on Placing

Recommended Methods Designed to Prevent Damage to Wood by Spikes and Tie Plates and Increase Life of Ties

(Abstract of Committee Report, American Railway Engineering Association)

A STUDY of several installation of screw spikes on some 230 miles of track leads the tie committee of the American Railway Engineering Association to the conclusion that conditions of line and surface of track and stability of roadbed have an important effect upon the holding power of the spike. Chief among rules and methods recommended by the committee in the design and construction of track with screw spikes is a provision for maintaining a clearance between the spike head and base of rail in order to free the spike from stresses due to wave motion in the rails. As the railways get longer life from ties by danger that spike killing, or damage to the wood will be a limiting factor in their life.

Some installations made in 1908, in good treated ties, were found to be thoroughly satisfactory and capable of many more years' life. Other installations, made at later dates, have not been so successful. The defects which seem to the committee to cause over-strain of the wooden threads of the tie which hold the screw spike include improper design of fastenings, wood and methods of installation.

Damage to Ties by Screw Spikes

The threads in the wood were found injured where the screw spike did not have an accurate and uniform pitch and diameter of core. The first placing of the spike injured a portion of the fiber, and further damage was done where the screw spike had been changed in connection with replacing a rail or tie-plate. The wood fibers at the top of the hole were found destroyed where the screw spike used had no pilot or small point on the end to permit its being screwed into place after being set in with a light tap of the hammer. That is, the holding power of the timber was destroyed for whatever distance the spike had to be driven in the hole. Therefore, the lighter the tap required to set the screw spike ready for being turned, the less the fiber of the tie was injured.

Distortion of the fiber of the wood was found where the head of the screw spike rested directly on the top of the base of the rail, this damage apparently depending on how much wave movement there was in the rail as trains passed over it. Spikes were found forced out of position, so as to injure the timber, where the following conditions existed: Tie-plates of insufficient size and thickness; no shoulder tie-plate used so that the spikes were placed against the outside edge of the base of rail and acted directly to hold the gage; no support or bearing to hold the head of the screw spike a prescribed distance above the base of the rail and provide a freeway for movement of rail without stressing the holding power of the spike; holes in the tie-plates unnecessarily larger in diameter than the screw spike.

Some soft wood ties were found which were not strong enough to hold the thread under the stress produced by the heavy traffic and axle loads carried.

The most common cause of destruction of the wood threads in the tie was found to be due to the driving of the screw spike with a hammer in starting. The committee has seen screw spikes hammer driven for one-fourth to one-third of the length of the threaded portion. This results in destruction of one-fourth to one-third of the holding power and in enlargement of the top of the hole, the latter permitting water to accumulate and causing further destruction of the wooden threads as well as corrosion of the spike.

Decay was found in ties where spike holes were bored after the tie was treated and no preservative put in the holes before applying the spike. Where the hole in the tie had not been bored deep enough to permit setting spikes down as the tie-plate embeds itself, the wood threads were stripped in an attempt to tighten the spike. A rather general condition of bent and partly pulled screw spikes was found at rail joints, due to creeping rail, the spikes being placed in slots at the joints. This resulted in the destruction of the wood threads of the tie. In a few cases these threads were found stripped where the spike had been turned too many times with a power machine.

Recommended Methods

The condition of line and surface and the stability of the roadbed were found to have an important effect on the holding power of the spike, the over-straining apparently beginning when there was more movement of the rail on the tie than could be provided by freeway space.

Based on the varying methods and results observed, the committee has stated the conditions it believes necessary for the protection of the tie in connection with a screw-spike installation.

The timber should be adequate in strength for the tonnage and maximum axle loads carried. For heavy traffic, hardwoods are considered preferable; such as white oak, various species of red oak, gum, beach, maple, birch and dense grade needle-leaf woods. Those woods belonging to the treatment class should be so treated.

Ties should be bored and adzed, and treatment applied afterward. The holes for screw spikes should be bored completely through the ties, except that special consideration should be given to this question where there is a heavy electric current in the track rail which might become grounded by this means. These holes should have the same diameter as the shank of the screw spike.

A shoulder tie-plate should be used, so designed that the spike does not in itself maintain gage, but holds the plate securely to the tie, thereby enabling the shoulder to maintain proper track gage without putting the spike in contact with the rail base. This will reduce spike cutting and mechanical tie destruction to a minimum.

Additional shoulders should be provided on which the spike head will bear, these being so made that the plate will be held securely to the tie while clearance will be provided between the spike head and the rail base sufficient to take care of the rail deflection due to loading and track surface conditions. This clearance will vary with the character of the subgrade maintained and weight of rail, but ¼-in. is recommended as good practice for 100-lb. rail with average high-speed conditions. This may be decreased to ⅛-in. on track of specially substantial construction where the speed

is low, or raised to ⅛-in. where the flexibility of the track is greater.

When the screw spikes are placed in slots of the angle bars, the rails should be anchored so that there is not an undue stress on the screw spikes from rails creeping. If the rail has to be allowed to run freely, as on bridge decks or trestles, the spikes should not be set in the slots of the angle bars.

The screw spike should have an exactly uniform pitch and size of core, with the diameter of its lower part decreased so that the beginning of the thread is slightly less than the diameter of the hole bored in the tie. It is essential that the spike be screwed in the wood without destroying the fiber of the wood. In order to accomplish this the spike must be started with a very light tap, just sufficient to get holding power in the threads to permit its being turned in the tie. For this purpose the form of screw spike adopted by the Association is considered essential. The committee urges that the present injurious practice of starting by driving the spike should be discontinued.

Full benefit of a screw-spike installation cannot be obtained unless the standard of maintenance of line and surface is fairly high as compared with the tonnage and character of ballast; this contemplates well-tamped track, fair line and surface and a foundation which is not too yielding. It is difficult to measure the damage done to a tie by a screw spike until some of the modern installations have had longer service. Conclusive figures will not be available until the life of these installations can be determined.

Wanaque Dam Contract Provides for Variable Labor Costs

IN ADVERTISING for bids for the construction of the Wanaque Dam, Passaic County, N. J., the North Jersey District Water Supply Commission specifies in the contract a wage scale upon which contractors may base their estimates, and agrees to pay an increase as great as 10 per cent in the labor costs after this year, in the event that the then prevailing wages are generally that much higher than the base scale named in the contract. In case wages decrease generally the stipulation is also made that the commission shall profit by a 10 per cent decrease. The clause in the contract referring to that special wage agreement follows:

If it shall be shown by the said record, to the satisfaction of the commission, that a rate of wages more than 10 per cent in excess of the rate stipulated in the base scale has been paid for any of the herein listed trades employed on this contract after Dec. 31, 1920, and if said rates in excess of the base scale shall have been first determined by the commission not to be unduly in excess of the then prevailing rates of pay on similar work, and are approved by the commission, then the commission shall pay to the contractor, in addition to the regular monthly estmate . . . a sum of money equal to the total amount of any such excesses of wages as have been actually incurred and paid after Dec. 31, 1920, by the contractor over said 10 per cent in excess of the base scale.

If on the contrary it shall be shown by the said record, to the satisfaction of the commission, that a rate of wages 10 per cent or more below the base scale has been incurred and paid in any of the listed trades during the period after Dec. 31, 1920, then the commission shall deduct from the net regular monthly estimates a sum of money equal to the total amount of any such difference between the rate actually paid to the contractor and a rate 10 per cent below the base scale, or, if the commission by its own investigation, after affording the contractor an opportunity to be heard, shall find that the prevailing rates of pay on similar work for any of the listed trades are more than 10 per cent below the base scale, then the commission may establish a new scale of wages predicated upon such prevailing rate and when such new scale is so established and copy thereof served upon the contractor shall deduct from the succeeding monthly estimate, beginning thirty days thereafter, such sums of money as shall be equal to the difference between the rate 10 per cent below the base scale stated in the contract and the rate in said established new scale.

The base rate specified in the contract follows:

Steam shovelman	$250 per month (26 days)
Craneman	50 per week (six 8-hr. days)
Carpenter	8 per day (8 hr.)
Mason	9 per day
Mason's helper	5.60 per day
Concrete finisher	9 per day
Plumber	9 per day
Drill runner	7 per day
Tool sharpener	7 per day
Tool sharpener with pneumatic tools	7.50 per day
Pipe fitter	8 per day
Pipe fitter's helper	6 per day
Engineman or engineer	46 per week (48 hr.)
Fireman	$150 per month
Rigger	8 per day
Machinist	1 per hour
Piledriver operator	50 per week
Electrical worker (including lineman)	8 per day
Electrical worker's helper	4 per day
Autotruck driver, five tons and up	35 per week
Autotruck driver, below five tons	30 per week
Teamster	35 per week
Labor, first class (including working foreman, handyman, mechanic's helper not listed above)	65c. per hour
Laborer	50c. per hour

The contractor must file with the Commission in such a form and for such periods as the Commission shall stipulate, a record showing the name of all employees and the hours worked, the wages paid to each and such other information as may be required. Time and a half is allowed for overtime, and double time for Sundays and holidays, except when otherwise stipulated, for monthly and weekly pay.

There are several other special provisions in the contract. For instance, in the excavation for the core wall the contractor is to have recourse first to methods described within the contract. If such methods fail to complete the core-wall excavation, and if other methods are used and their cost and that of all the work previously done exceeds the price which would be paid under the respective appropriate items of the contract, then upon the determination in writing of the Commission to that effect, the work of completing the excavation of the core-wall trench will be regarded as not susceptible of classification under certain specified items of the contract, and payment will be made by issuance by the Commission of an order to the contractor for such work and materials, although they are neither specified nor shown on the contract drawings. The contractor is also allowed partial estimates upon materials delivered to the site though not actually at the time of the issuance of the estimate being incorporated in any of the construction. Such materials and the prices allowed are as follows:

Portland cement, at the rate of $2.50 per bbl.
Miscellaneous iron and steel for reinforcing concrete, at the rate of 5c. per lb.
Steel sheet piling, at the rate of $1 per sq.ft.
Sluice gates and stands, complete, the lump sum of $1,000 each.

Except through the approval of the engineer and the establishment by the Commission of a new base scale to cover them, no trades or occupations not listed above will be allowed extra compensation. Any new scale so created is valid only for the calendar year in which established.

LETTERS TO THE EDITOR

Vote on Am. Soc. C. E. Questionnaire!

Sir—The attention of the corporate members of the American Society of Civil Engineers should be called to the fact that only about one-third of the membership have thus far voted on the very vital matters, affecting the future of the Society, contained in the questionnaire, votes on which will be counted April 14, 1920.

It is not possible that any member interested in the Society should neglect to vote.

Those members who desire the progressive development of the Society along conservative lines will vote in the affirmative.

Attention should be called to the fact that it is only votes and not good intentions that will be counted.

RICHARD L. HUMPHREY.

Washington, D. C.

Past-President, Am. Soc. C. E., Endorses Program of Development Committee

Sir—Your editorial of Feb. 26 called forth by a circular sent out by certain members of the American Society of Civil Engineers, entitled, "A Word of Caution," has already borne good fruit in bringing out discussion of society matters through the columns of the technical journals, a practice which has been pronounced unethical and unprofessional. The publications of the society and the method of communication by circular are inadequate for occasions like the present. The successful use of circulars requires a corrected mailing list.

It is a good omen that the most prompt and sensible means of communicating with society members is being adopted without restraint. With several shining examples already preceding me, I feel that I may with entire propriety discuss the circular above referred to and other matters connected with the report of the Committee on Development.

The quotation from the constitution of the American Society of Civil Engineers, viz: "Its object shall be the advancement of engineering knowledge and practice, and the maintenance of a high professional standard among *its members*," (italics mine) brings clearly into view the question of whether the society should cling any longer to such selfish objects. Engineering should unquestionably be a profession. No group of engineers should or can monopolize it. It is the duty of the true engineer to promote the profession and not the interests of any group. One need only look around him to discover that there are thousands of qualified engineers who are not members of any society and it is not the fault of these engineers. How can "a high professional standard" be "maintained" unless all reputable and qualified members of the profession join together in a movement to do so?

The potent influence of the American Society of Civil Engineers in establishing the prestige of the profession is admitted, but the point was reached long ago when its eyes should have been opened to the fact that its self-centered conservatism was resulting in the growth of new societies in a field of which it had, and might have kept, full possession, and a consequent tendency to lower the standard of professional ethics, which it cherishes so greatly. It is vain to grieve over lost opportunities and we should now set about to make the very best that is possible out of a bad situation.

I think there is a misconception of the meaning of "welfare work." If used at all in connection with a movement to make engineering a profession, it should not be understood to embrace only the boosting of compensation. I do not conceive it to be the duty or best interest of the professional engineer to undertake to secure for any person who engages in work connected with engineering, financial reward greater than their service is worth, but it is their duty and interest to see to it that competent engineers are protected in the practice of their profession, whether employed or not, and no matter to what society they may or may not belong.

The report of the Committee on Development was the work of a representative committee of well selected members. No doubt there are many who will disagree with some of its recommendations. All of them are not entirely to my liking. However, the report points a way for the representative men of the profession to unite in impressing upon the public the fact that good engineering is necessary to good government. The American Society of Civil Engineers has already joined with other societies through Engineering Council in advocating wise public policies in matters where engineering is involved. The machinery for doing so is not sufficient. The report of the Development Committee and the Conference Committee point the way toward perfection of this machinery. The way may not appear smooth and straight, but engineers either know or can find out how to take out any kinks that may be found to exist.

We have sat still and contemplated our self-sufficiency too long already. I think the time is at hand when it is better to act with the possibility of some mistakes being made, which can be corrected, than to remain inactive until others prepare a royal road for us.

I hope the membership of the society will not permit the questions now before them to be lost by default and am convinced that if a representative vote is cast it will approve the recommendations of the Development Committee.

HUNTER MCDONALD.

Past President, American Society of Civil Engineers.

Proposed Increase in Am. Soc. C. E. Non-Resident Membership Dues

Sir:—The undersigned five corporate members of the American Society of Civil Engineers have forwarded to the secretary a proposed amendment to the constitution of the society, relating to "Article IV, Dues.," to the effect that the annual dues of all corporate members, whether resident or non-resident, shall be $25.

Question 6 of the questionnaire relating to the report of the Development Committee limits the increase in dues of the non-resident members to $5 and it has seemed that this increase will not provide adequate funds. The prices of printing and publication are probably more than double what they were a few years ago, and with credit inflation salaries must be advanced and there will be a general increase in the expense of the society. Unless something is speedily done, the society will be unable to carry on the publications and the activities recommended by the Development Committee.

The proposal to advance the dues of non-resident members seems a fair one, in view of the fact that there are now some 1,700 resident members who probably pay to the society some $16,000 over and above what is paid by the non-resident members. The cost of the semi-

monthly meetings held at the United Engineering Societies Building probably does not amount to more than $3,000 or $4,000, so that it would pay the resident members, as a business proposition, to assume the expense of the society meetings and thereby save some $12,000.

Argument has been advanced that the resident members have the benefit of the engineering societies library. As a matter of fact membership in the society is entirely unnecessary for such privilege, since the library is free to any person who desires to make use of it.

PERCIVAL CLOW,
WILLIAM J. HEISER,
WALTER S. ST. JOHN,
ALFRED W. A. EDEN,
C. E. HAYWOOD.

New York City.

Economy of Low Grades for Heavy Traffic

Sir—A summary of economics of a grade of 0.2 per cent proposed for the Hocking Valley Railway is given in *Engineering News-Record*, Jan. 29, 1920, p. 244. It has generally been accepted that a gradient of 0.3 per cent was about the economic limit of reduction, whereas this revision contemplates the expenditure of nearly $1,500,000 for a further reduction to 0.2 per cent. Discussion of the following points would be interesting:

1. Is a train of from 6,000 to 8,000 tons a practicable operating unit even on a level track?

2. The horsepower required here for a trip is proportioned to the resistance (distance and rise) and tonnage irrespective of the gradient. The horsepower in this case, assuming the rise and distance unchanged, will be about 25 per cent greater for the theoretical 0.2 per cent loading than for the 0.3 per cent. Will not the cost and running time of the train for 0.2 per cent grade be greater than for the lighter train for 0.3 per cent, taking the division as a whole?

3. The engineer plants the seed for an improvement, the investor waters it with his capital, but after the labor unions and the public have helped themselves little of the harvest is left for the investor and none for the engineer. From an investor's standpoint is any expenditure for improvement justified until the investor has a chance to realize a just share of the saving due to his investment?

A. C. DENNIS,
Consulting Engineer.

Seattle, Wash.

[The comments in the above letter were submitted to Mr. Michel, chief engineer, Hocking Valley Railway, from whom we have the following reply.—EDITOR.]

Sir—In relation to the comments upon the study of grade reduction on the Toledo Division of the Hocking Valley Ry., I do not know how generally a gradient of 0.3 per cent has been accepted as the economic limit of grade reduction. It appears to me that no limit should be accepted which lies well within the zone of economic possibilities. As long as net earnings due to improvements show a fair return on the investment, the proposition warrants the expenditure of funds necessary to install the facility.

As to the first question: "Is a train of from 6,000 to 8,000 tons a practical operating unit?" The tendency to increase capacity of freight cars will eventually minimize the objection to great length of train and at the same time tend to increase the possible tonnage of each train. Since ton-miles hauled is the thing which is to be obtained, it becomes necessary to increase train tonnage. Shorter working days for train crews require certain speed and time limit between terminals. Reduction in speed is generally the result of ruling gradient. To maintain speed with a maximum tonnage, it becomes necessary to have minimum grades.

Labor shortage frequently enters into the problem, requiring the greatest efficiency possible in accomplishing the aim sought, which is ton-miles hauled per train. Lack of sufficient motive power frequently adds to the burden of the railroad. This can be greatly relieved by increasing the tonnage per train. To do this successfully, ruling gradients must be reduced to a minimum so that speed may be maintained throughout the trip, and overtime avoided whenever possible. Freight trains of large tonnage are frequently resorted to by the use of helper engines at heavy grades. Such units are considered practical, and the tendency is to increase tonnage wherever this is possible.

In the above letter it is stated that: "The theoretical horsepower required for a trip is proportional to the resistance (distance and rise) and tonnage, irrespective of the gradient." The reduction in ruling gradient, however, makes it possible to increase tonnage per train, which is the thing sought. It is admitted that the horsepower per train required to haul the heavier tonnage is increased in proportion to the increase in tonnage per train. This increases the fuel and water consumption per train for the proportion of the line on which opposing grades are encountered. On descending grades, no additional power is required.

To offset the additional cost of fuel and water per train, we have the revenues derived from a 25 per cent increase in train loading for a grade reduction from 0.3 per cent to 0.2 per cent. This is equivalent to approximately 1,000 net tons per train for the 2-10-2 type engines, which is accomplished with little if any increase in cost of labor of train crews or motive power.

Revenue per ton over the division being known, it is simply a matter of comparison of revenue and expenses. This consists of revenue due to increased loading as against cost of additional fuel and water, and interest on additional investment of capital for construction of a grade of 0.2 per cent over one of 0.3 per cent. The running time required between terminals will not be increased on account of reduction of gradient.

Further, the question is asked: "From an investor's standpoint is the expenditure for improvement justified?" If the net earnings of the improvement show a fair return on the money invested, the proposition is a profitable investment. Such an investment should be made from an economic standpoint. What inures to the profits of the investor in railway facilities and improvements benefits the public in general. Other things being equal, the road having the lower cost of operation has a decided advantage over the one not so favorably situated.

I am convinced that the proposition is a profitable investment as far as it applies to the Hocking Valley Ry. When the entire division is double tracked, there will be few occasions to stop loaded trains except for fuel and water. These necessary stops are so located that they will not be on ruling gradients. This will minimize the damage frequently occurring to equipment when starting a train.

W. MICHEL,
Chief Engineer, Hocking Valley Ry. Co.

Columbus, Ohio.

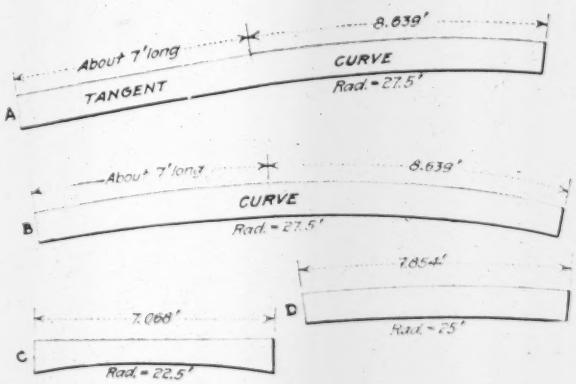
HINTS FOR THE CONTRACTOR

Curves Lined Accurately to Templet in Sewer Tunnels

BY A. L. SEARS

Engineer in Charge of Sewer Construction, Detroit, Mich

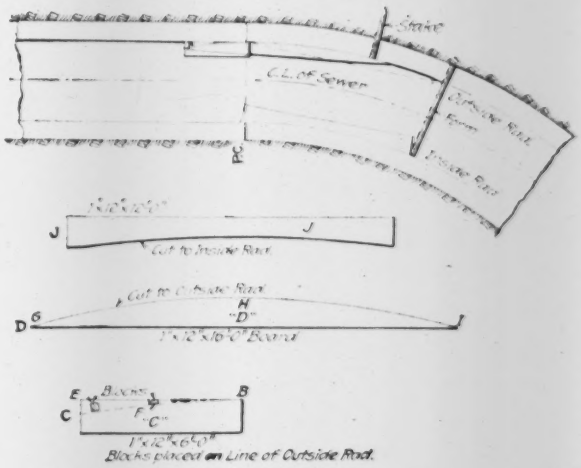
VERY accurate and smooth workmanship has been secured in Detroit, Mich., in placing brick lining on curves of sewer constructed in tunnel, by the templet method illustrated in Figs. 1 and 2. The second method is now used more than the first, over which it has some advantages. The first method has been used longer than the second, however, and both are efficient. The two are described to permit the contractor to exercise choice if for any reason either method appears preferable under the conditions.



Method I.—Assume that a 25-ft. radius curve with an angle of 90 deg. is to be lined with two rings of brick for a 5-ft. circular sewer. The length of curve outside is 43.197 ft., and inside it is 35.343 ft. It is to be lined in five equal drives. The arc lengths for each drive are 43.197 ÷ 5 = 8.639 ft. outside, and 35.343 ÷ 5 = 7.068 ft. inside. Four templets, *A*, *B*, *C*, and *D*, are cut from 1 in. pine boards of 12 x 16 ft. An easy way is to lay out tangents and curve on an asphalt street intersection and then cut the templets to the lines.

With the tangent lined up to the point of curve, templet *A* is used for the first drive by placing the 7-ft. tangent portion against the completed lining and laying the first drive of the curve to the projecting curved portion. Then templet *B* is used in a similar manner for drives 2, 3, 4 and 5. Finally, templet *A* is used reversel, to start the tangent. Templet *C* is used only as a guide by which to lay brick on the inside arc and templet *D* is used as a guide for laying the center row when starting each drive. Accuracy is controlled by templets *A* and *B*.

Method II.—Three templets, as shown by Fig. 2, are employed. With the tangent lined up to the point of curve templet *C* is placed as indicated by the curve diagram with corner *B* at the point of curve. On *C* are nailed two blocks *E* and *F* with their edges and the corner *B* tangent to the arc of the curve to be lined. Then templet *D* is used by placing the curved edge *G H I* against the blocks *E* and *F* on templet *C* and sliding *D* ahead any distance desired to line in the first drive of the curve. Templet *D* is used to the point of tangent when templet *C*, reversed, is again used to line the tangent. Templet *J* is used to guide bricklaying on the inside arc as indicated by the diagram.



This templet method of lining in curves was originally used by the writer and has been improved by W. D. Edgecomb, assistant engineer.

Keeping Track of Progress on General Motors Building Excavation

THE Durant building in Detroit which the General Motors Co. is erecting to house offices and general laboratories for all of its related companies is one of the largest area office structures yet built. It covers a city block, 522 ft. long and 364 ft. wide on Grand Boulevard between Cass and Second Avenues and extends west to Milwaukee Avenue. A bonus was given the subcontractor for removing material in excess of 1,500 cu.yd. per day, and the general contractor's progress staff kept records in perhaps more than usual detail. These records were added to the regular profile charts daily and every week a sketch of the site indicating the location of the progress was prepared. It is not practicable to reproduce all of the notes on the progress profiles, which contain a complete record of the weather, delays, loads, yardage and number of trucks for both day and night shifts.

Three steam shovels and 35 trucks working 20 hours per day removed nearly 100,000 cu.yd. of clay in 89 days from the site. Good management, utilizing ordinary equipment, but doubling up on the time it was used, enabled the contractor to carry on the job at a remarkably fast rate when he was able to work, considering that all of the material had to be hauled through the city streets.

The contract was to be completed in 60 days from June, 1919, but rain, delays due to the progress in removing the buildings and the ordinary minor delays for repairs, etc., prolonged the time to 89 days, although 97 per cent had been removed two weeks previously. Counting out 14 Sundays and holidays and 6 days for rain when no work was possible, 6 days in getting started and 13 days at the end cleaning up after 97 per

cent had been taken out, leaves 51 days for the actual working time, during which the average rate was 1,900 yd. daily. The maximum day was July 25 when the day crew registered 296 loads with 47 trucks and the night crew 300 with 41, a total of 2,556 cu.yd. Even at that there was a delay of 3¾ hours with one of the shovels in the day time and 1 hour at night from blasting. Night work did not start until June 12, but it produced the first bonus day. For at least 14 times the record indicates delay on account of shortage of trucks and 15 times the trucks waited on the shovels.

Uniformly the material was typical Detroit blue clay easily handled when dry but sticky and slippery when wet, necessitating plank roads for the trucks.

An average of thirty-five 4-ton trucks were used but the number varied from 30 to 40, being paid for by the load by the sub-contractor. The dump was 4 miles away on property being filled in. Two inclines were used with slopes of 30 deg. Loaded, the trucks could not negotiate this grade and a hoist with cable attached to the front axle pulled them out of the excavation.

The site was occupied originally by the 4-story Hyatt Roller Bearing reinforced-concrete building, a long row of flats and several dwellings. These are mentioned because their removal dictated to a certain extent the excavating procedure. The Hyatt building was moved to a new location across the Cass Avenue end of the site and across Milwaukee Avenue. The other buildings were demolished but housing conditions in Detroit were so congested, many hundreds of people living on vacant lots in tents at the time, that the occupants insisted on remaining to the termination of their leases. This accounts for the irregular progress of the steam shovels, shown graphically by the series of progress charts.

The area marked "1" within the area bounded by the alley was excavated to the finished 16-ft. depth first, using an incline to Second Avenue. Before this was completed an 8-ft. cut was taken from the Cass Avenue end (left hand in the charts) so that the Hyatt building might be moved over it without jacking up the building to place the shores. By this time most of the buildings on Grand Boulevard side (bottom in the charts) had been demolished and excavation proceeded across the alley. Before this latter corner was taken out completely the Hyatt building had been moved and excavation proceeded behind it to the full 16-ft. depth.

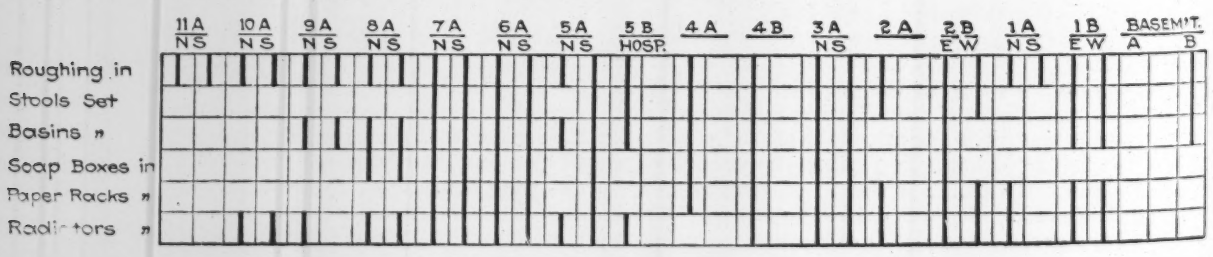
The Durant building is being constructed for the General Motors Co. by the Thompson-Starrett Co. The William Hayes Co. was the sub-contractor on the excavation. Albert Kahn is architect.

Diagram Checks Completion Small Details

DIFFICULTY in checking the completion of details in large building work is reduced by using the simple check sheet indicated by the diagrams. This particular sheet of which only the top portion is shown was used on work for the National Cloak & Suit Co. at Kansas City, an 11-story warehouse of 690,000 sq.ft. of floor, which was occupied with a full force on Jan. 26, while considerable work remained to be done. The owners desired the quickest possible cleaning up in order to avoid constant hindrance to efficient operation.

The sheet covers the item of "toilets" which always require considerable watching. At the left are itemized the details, and across the top are column headings 11-A, 10-A, 9-A, etc., representing floors in A and B building, and the N and S refer to north toilet and south toilet, respectively. In each column a vertical heavy line indicates the work completed, a check mark indicates absence of that detail in that particular toilet and a blank shows work yet to be done. Colored pencils may be used to show progress as between weeks, black for the initial week of the record and a new color for each succeeding period.

When the general superintendent demands records of this sort from the superintendent and the superintendent on the job follows these sheets for daily execution, there is nothing left to memory and if there is blame for non-execution it can be put on the right shoulders. The contractors for the building were Wells Brithers Construction Co., Chicago, and the check sheet is regularly used on their work.



SAMPLE DETAIL CHECK SHEETS

Drilling in Frozen Ground

By Thomas Tremblay,
City Engineer, Sherbrook, Quebec

IN your issue on March 11, p. 542, my attention was drawn to an article written by L. G. Hall, construction engineer, New York City, on the means of excavating frozen ground by the use of heated steel bars for the making of blasting holes. My experience, this past winter, has proved to me that the best and quickest means of drilling these holes is by the use of steam. We carried on our work of constructing a trunk sewer all through last winter. When we came across places where the frost was more than 4 ft. deep, we used ½-in. iron pipe connected to a steam hose with a pressure of 80 to 100 lb. This pipe was directed into the ground where we wished to do the blasting and bags were placed around the pipe to keep the steam down. Then, with the steam turned on, the pipe was pressed into the ground. It took two or three minutes to make a hole 4 ft. deep. When we wished to thaw the ground without blasting, the holes were sunk closer together and the steam kept on for a longer period, according to the nature of the frozen ground.

I have found that the use of steam for cutting trenches in frozen ground, makes trenching very easy and saves considerably on the cost compared with the old methods.

NEWS OF THE WEEK

New York, April 8, 1920

Engineering Council To Confer With Members of Congress

Engineering Council will meet in Washington April 15. In addition to discussing various business matters, the members of Council are to confer with a number of the Senate leaders in the office of the Vice-President. At that time a formal offer will be made by Engineering Council to act in an advisory capacity on any public engineering matter. It will be pointed out that the engineers of the country are anxious to be of assistance to Congress in promoting the public welfare. A similar meeting with House leaders is being planned to take place in the office of the Speaker.

In the evening the members of Council will entertain a number of the Congressional leaders and executive officials at a dinner to be given at the Chevy Chase Club.

Personnel of New Dwight P. Robinson Co.

Reorganization of Dwight P. Robinson & Co., Inc., and Westinghouse, Church, Kerr, Inc., announced in these columns March 25, 1920, p. 647, is expected to be complete by May 1. The new merged company will be known as Dwight P. Robinson & Co., Inc., and will have the following principal officers, the letters in parenthesis indicating the respective previous affiliation in one of the two merging companies: President, Dwight P. Robinson (D.P.R.); vice-presidents, T. N. Gilmore (W.C.K.), I. W. McConnell (D.P.R.), R. N. Henderson (D.P.R.), A. K. Wood (W.C.K.) and D. H. Bean. The new company has engaged the ninth floor of the Grand Central Palace, 45th St. and Lexington Ave., New York City, and will open offices there about May 1. It will continue the business carried on by its two predecessors as an engineering company, designing, building and managing industrial and engineering projects.

Delay in Highway Construction Urged in Ohio

A halting of road construction in Ohio until there is a readjustment of economic conditions is indicated in a letter sent recently by A. V. Donahey, state auditor, Ohio, to A. R. Taylor, highway commissioner. Supporting such a contention he shows that the first six contracts let in January and February, 1920, for 15½ mi. of roads, built of waterbound macadam, bituminous macadam, brick, plain concrete and warrenite, will cost on an average for the six contracts $35,893 per mile. On March 25 thirteen contracts involving 44 mi. were offered, and but two bids received.

Joint Port Control of New York Now Before Legislatures

Bills have been introduced in both the New York and the New Jersey legislatures to authorize the establishment of an interstate Port Authority to control the port of New York. The procedure to be followed if the bills become law would be for the two states to rewrite their long-standing agreement fixing their rights and obligations in the waters between them. The new agreement provides for the establishment of a Port Authority to be composed of three members from each state, which authority shall have control of the port. The area embraced by the port extends from near Yonkers out into New Jersey near Paterson, Caldwell, Summit, New Brunswick and out into Long Island as far as Jamaica. Two of the New York representatives must come from New York City and two from the port section of New Jersey. An important sentence in the compact reads: "No city within the Port District shall be bound by the comprehensive plan unless and until it has approved of the same." This "comprehensive plan" has been under consideration by the New York-New Jersey Port and Harbor Development Commission for nearly two years and it states that it will be made public before July 1.

Transfer of More War Equipment for Road Building Proposed

A bill directing the Secretary of War to transfer to the Department of Agriculture, for distribution among the states, certain additional surplus equipment, to be used for road building purposes, has been introduced by Representative Reavis. The bill specifies 500 10-ton caterpillar tractors complete with spare parts; 200 mobile machine shop units, complete with spare parts; shop machinery and machine tools and equipment suitable for repair and rebuilding shops for motor propelled vehicles. The state receiving the property is to pay 20 per cent of the estimated value of the property. From this sum, however, the state may deduct freight charges.

Society for Municipal Improvements To Meet in St. Louis

The next convention of the American Society for Municipal Improvements will be held at the Planters' Hotel, St. Louis, Oct. 12-15. *Engineering News-Record* is informed by Charles C. Brown, secretary, Valparaiso, Ind., that the local committees have all been appointed and are busy and that they promise a comprehensive view of the public works of St. Louis, and the co-operation of other engineering societies.

Harvard Adopts Co-operative Plan of Training Engineer Students

For 16-Month Period Classes Will Alternate at 2-Month Intervals Between Class Room and Industrial Work

The Harvard Engineering School will inaugurate next June a new plan of engineering training including co-operation with the industries. The first two years of the program are substantially as in other schools, except that there is no differentiation between mechanical, civil and electrical engineers and that the students are not segregated either in their classes or in their social relations from the undergraduates in Harvard College and thereby escape the narrowing influence of an exclusive association with other engineering students. They must take certain courses in mathematics and in pure science, but have the opportunity of obtaining as broad an education as college students of their class. The work of the senior year is also carried out along the usual lines.

The combined engineering study and work in the industries starts in June of the sophomore year and lasts until the October at the beginning of the senior year. During the sixteen months the class is divided into two equal sections, which alternate from study to industrial experience at two-month intervals, with one vacation period for which the ambitious student may substitute industrial work. Those students who take the regular offering get eight months of study (which is the actual study time at present) and six months of experience in the industries; those who so desire may have eight months in the industries. There will be a continuous supply of students to the industries and continuous instruction in the school. Courses given within this period will have to be duplicated.

The scheme outlined above is optional, but the present indications are that it will be elected by practically all students in the school. It adapts itself well to graduates in arts or sciences from Harvard or other colleges who enter the third year of the engineering school, even if they enter in August or as late as October.

The co-operation with the industries will be under a director who will arrange with the industries for placing the students at such work as will give them the best opportunities for experience. The students will receive the same pay as other workmen doing similar work and will be treated by the industries like other workmen except that the director of co-operation will have freedom of access to each student

at any time and will be permitted to arrange the general character of his work. The director will meet groups of the students in the evenings during their industrial period to discuss with them their problems and experience.

Each student will be given a syllabus of questions relating to the type of work which he is doing, the answering of which will require him to observe closely, not only the technical processes which he himself is carrying out, but also the whole system of management of the factory and such general technical details as he may have opportunity to observe. The syllabus will also require him to apply to his observations that body of engineering theory which he has acquired during his studies.

Announces Valuation Methods for Spring Valley Properties

E. O. Edgerton, president of the California Railroad Commission, in written instructions to Richard Sachse, chief engineer of the commission, directs him to proceed with the valuation of the Spring Valley Water System as an aid in the purchase of that system by the city of San Francisco, and calls for investigation and report on the following:

(A) Cost to produce the specified properties, using current prices for labor and materials as of a reasonable construction period ending March 1, 1920, applying these prices as of the times when labor would be employed and materials purchased under the construction program.

(B) Condition per cent. as of March 1, 1920, of the specified properties. This will necessitate an estimate of actual depreciation existing in the properties on March 1, 1920.

(C) Cost of acquisition of lands, to be obtained by ascertaining the market prices as of March 1, 1920.

(D) For such purposes as may hereafter be determined upon, price for Spring Valley properties placed before the voters of San Francisco in 1914; this price to be analyzed as closely as possible and added to cost of additions and betterments found to exist March 1, 1920, and specified by the city, with consideration to depreciation.

(E) Other facts which may assist the commission in giving proper weights to the items under A, B, C and D.

Extend Jurisdiction of California Power Administrator

As a result of investigation and conferences on the water shortage in California, announcement of which appeared on page 543 of *Engineering News-Record*, March 11, 1920, the California Railroad Commission has issued an order extending the jurisdiction of Power Administrator H. G. Butler. The new order empowers him "to exercise jurisdiction over the electric power supply of all the electric utilities throughout the state of California," and authorizes him, with the approval of the commission, to take such action as may "effectuate the purposes in the commission's opinion set forth in the matter of electric power control and administration." The new order, which is effective March 31, also gives the power administrator jurisdiction over rates charged for electrical energy supplied by one company to another.

Northwestern Members Act on Am. Soc. C. E. Questionnaire

The Northwestern Association of Members of the American Society of Civil Engineers, at its bimonthly meeting held in Minneapolis, March 12, endorsed an affirmative vote on the questions contained in Section A (External Relations) of the questionnaire. On the Development Committee's report, now before the membership of the society for vote, an affirmative vote was unanimously recommended on questions 1 to 6, inclusive, of Section B (Internal Relations).

Morris Knowles, Inc., Staff Dinner

A dinner was given in Cleveland March 13 for Morris Knowles and engineers of the Pittsburgh staff of Morris Knowles, Inc., by the Cleveland division of that engineering corporation. The Cleveland division, now in charge of R. F. MacDowell and R. E. Garvin, was formerly the organization of the late R. Winthrop Pratt, consulting sanitary engineer of that city.

The purpose of the dinner was the furtherance of personal relations between the engineers of the Pittsburgh and Cleveland offices of the organization. In addressing the members of his staff, Mr. Knowles announced that industrial housing, rate making and valuation work would be added to the Cleveland office's former specialties of water supply and sewerage.

Engineers for Railway Labor Board Named

The American Association of Engineers has conferred with the other groups of subordinate officials established by the recent order of the Interstate Commerce Commission, and has nominated W. F. Milligan and W. J. Potts for members of the Railway Labor Board provided by the Transportation Act of 1920.

Forest Laboratory To Celebrate

The tenth anniversary of the U. S. Forest Products Laboratory, at Madison, Wis., is to be celebrated in June by a two-day meeting at which there will be addresses and a dinner, together with an inspection of the laboratory and its work.

Would Relieve Contractors of War Cost Increases

In the United States Senate a bill has been introduced by Senator Stanley, of Kentucky, which provides for the relief of river and harbor contractors who have suffered losses as a result of the increased costs brought about by the war. The bill covers contracts for river and harbor work, which were entered into prior to April 6, 1917, but which had not been completed on that date. The bill also provides for the relief of contractors and their bondsmen in cases where contracts were cancelled.

Labor Problems and City Contracts at St. Louis, Mo.

Under the terms of an ordinance passed by the Board of Aldermen of St. Louis, Mo., which it was expected at latest accounts would be signed by the mayor, the city or contractors for the city when engaged in the construction of public works must give preference to the employment of (1) citizens of St. Louis, (2) other citizens of the United States when citizens of St. Louis are not available and (3) may employ aliens only when (1) and (2) are not available. This applies to foremen, mechanics and laborers of every kind. The ordinance also provides that all employees on public works must be paid not less than the prevailing rate of wages as fixed by city ordinance.

It is reported that the ordinance is causing a great deal of agitation in St. Louis construction circles for two reasons: First, because of the provision barring aliens from employment, which a great many consider to be unconstitutional, and yet which if not strictly carried out might offer ground for contest of special tax bills issued against public work; and, second, because practically a union scale is established by the ordinance on all work.

Sewerage and paving work has heretofore been non-union and paving work has generally been manned by negro labor which throughout the last season was paid from 35 to 45c. an hour. Under the new scale wheelbarrow men handling concrete from the mixer and the laborer placing concrete will be paid 80c. Sewer work has generally been manned by alien laborers, Austrians or Italians, which were paid 45 to 50c. and not over 55c. in the fall of 1920. These laborers are now scarce and would probably demand more, but under the terms of the ordinance they cannot be employed if Americans can be shown to be available, no matter how poorly qualified the American laborers may be.

It is felt by men in St. Louis that the ordinance may prove to be a last straw and that with sewers and paving on minor residence streets costing the property owners $11 and $12 a front foot before the ordinance becomes effective, the city is very close to the point where public improvements should be stopped.

To Resume Welland Canal Work

Work on the new Welland Canal, which will provide a 25-ft. waterway between Lakes Erie and Ontario, is apparently to be resumed by the Canadian government. During the war all operations on the canal practically ceased and last year an effort was made to get together machinery and to clean up preparatory to resumption. It is now announced that $5,500,000 has been spent in the Dominion estimates for the current year, which means that it is the intention of the government to go ahead with construction.

$47,000,000 Deficit for Canadian National Railways

That the total operating deficit, including fixed and interest charges, of the Canadian National Railway system was $47,000,000 last year was indicated in the statement made before the House of Commons of the Dominion, March 30, by Hon. J. D. Reid, Canadian Minister of Railways and Canals. The report includes the Grand Trunk Pacific which is in the hands of a government receiver. The items of the deficit are as follows:

Operating loss, Canadian Northern Ry.	$6,500,000
Operating loss, Intercolonial and Transcontinental Rys.	7,500,000
Interest and fixed charges, Canadian Northern Ry. and Intercolonial and Transcontinental Rys.	19,000,000
Operating loss, Grand Trunk Pacific Ry.	5,500,000
Fixed charges, Grand Trunk Pacific Ry.	8,500,000

The Minister said he considered the Grand Trunk Pacific Ry. and the Transcontinental as colonization lines and did not think it would be possible for them to make expenses for many years.

St. Louis Garbage Contract Renewed

The contract for garbage disposal by feeding to hogs made about a year ago between the city of St. Louis, Mo., and Guy Caron, has been renewed for another year on almost the same terms as before (see *Engineering News-Record*, Feb. 20, 1919, p. 400.)

Relief Promised to Contractors on Naval Structures

Through a resolution recently introduced into the House of Representatives the Secretary of the Navy is authorized to receive and investigate claims from contractors, sub-contractors and material dealers looking to reimbursement for actual losses sustained on war contracts. Recovery is to be allowed on losses "brought about by the action of Government agencies after the date upon which such contracts were entered into and which have arisen under contracts made between April 6, 1917, and Nov. 11, 1918, or under contracts which were due for completion after April 6, 1917." Applicants must file claims within 60 days of the passage of the act and in the case of contracts uncompleted at the act's passage, preliminary claims must be filed within 60 days.

Claimants must file an affidavit that in all work undertaken for the Navy Department no greater net profit than 6 per cent was realized. The Secretary of the Navy is also authorized to waive damages collectible from delays in completion of contracts where the delay is due to the action of Government agencies. The bill has been referred to the committee on Naval affairs.

A. A. E. Has 15,104 Members

The membership of the American Association of Engineers at the close of business on March 31 was 15,104. Almost three times as many applications were received this March as in the corresponding month last year.

Japan Commission to Study Tunnel Construction Problems

A Japanese commission, according to press reports, is being formed to make a study of American and European tunnel-construction practice with a view to throwing light on the cost and main construction problems in the proposed 10-mile tunnel under Shimonoseki Strait. This tunnel would connect the main island of the Japanese group with the island to the south on which the City of Nagasaki is located and where large industrial development has taken place.

New Road Institute to Furnish Material Prices to Members

After a two-day meeting recently held under the auspices of the three South Carolina state colleges and the State Highway Department, the road builders of South Carolina organized themselves as "The South Carolina Good Roads Institute." Officers were elected and a secretary appointed. A part of this secretary's duties is to keep the members of the institute informed as to current prices of cement, pipe culvert, structural and reinforcing steel, stone, and unit prices of construction work.

Four Texas Counties Vote Total of $450,000 for Roads

During February four Texas counties voted a total of $450,000 in bonds for road improvements. The counties were Aransas, Calhoun, Jeff Davis and Houston. Aransas Co. voted 5 to 1 to issue $100,000 worth, a measure that was defeated less than two months previous to the successful election Feb. 10.

Survey of Memphis Water Works

The engineering firm, Chester & Fleming, Pittsburg, has just completed a survey of the water department of Memphis, Tenn., on which it has been engaged for several months. The report shows that about a million dollars will be required to carry out the improvements necessary to meet the present and immediate future demands of the city. The present system involves the use of pumps which force the artesian supply through the system. The source of the supply is reported to be adequate, but in order to put the works in good condition, the report recommends overhauling much of the present machinery and making new installations in certain cases. A reservoir is also recommended to be built. At the present time, the system has no reservoir or other means of reserve supply. The Memphis survey was carried out under J. N. Chester, who personally conducted the investigations.

Large City Planning Commission for Los Angeles

A city planning commission of 51 members has been created by an ordinance passed by the City Council of Los Angeles, Cal., on March 5. The members of the commission are to serve without pay and "shall be persons of recognized ability and conversant with such matters as come within the scope of city planning." The City Council will select from the 51 members of the city planning commission an executive committee of nine members. This committee will have such powers and duties as may be conferred upon it by a future ordinance of the council. The officers of the commission will be chosen from the membership of the executive committee. The authority is given the commission to appoint a secretary and technical employees and assistants. A quorum will consist of fifteen members, but a majority of the commission is required for such matters as demand votes of record. The ordinance provides that the commission shall be a consulting body to the Mayor and Council in various city planning matters, having to do "with the orderly and consistent physical developement of the city." It will be the duty of the commission to prepare plans and to collect plans and suggestions prepared by the various city departments bearing upon the present physical conditions and future growth and development of the city, and to classify and co-ordinate them.

Public Roads Get Appropriations

The expenditure of $490,620 in roads investigations by the Bureau of Public Roads is provided in the agricultural appropriation bill as it passed the House. Some of the items entering into that total are as follows: Salaries, $117,900; for inquiries, in regard to systems of road management, $36,200; investigations of methods of road making, $102,300; investigations of chemical and physical character of road materials, $77,020; investigation of farm irrigation, $62,440; investigation of farm drainage, $53,760; investigation of domestic water supply on farms, $25,000.

Engineer Sues for $57,897 Additional Compensation

Bernard Enright, formerly director of the Eastern Testing Laboratories, Allentown, Pa., has started action in the U. S. Eastern Pennsylvania District Court against Fuller-Lehigh Co., Fuller Engineering Co., Lehigh Stoker Co., Allentown Portland Cement Co. and J. W. Fuller for $57,897.50 alleged balance due for salary and a share of the profits of the laboratories agreed upon when he assumed their direction.

The parties concerned are all well known in the cement industry. Mr. Enright, a member of the American Society for Testing Materials, is now practicing as consulting chemist and cement expert in Camden, N. J.

Civil Service Examinations United States

For United States civil service examination, listed below, apply to the United States Civil Service Commission, Washington, D. C., or to any local Office of the Civil Service Commission, for form indicated.

Senior structural engineer, grade I, $3,000 to $4,000 per year. Applications may be filed until further notice.

Senior structural engineer, grade II, $1,800 to $2,700 per year. Applications may be filed until further notice.

Assistant appraisal engineer, $1,800 to $3,300 per year. File applications by Aug. 2.

Appraisal engineer, $3,600 to $4,800 per year. File applications by Aug. 2.

ENGINEERING SOCIETIES

Calendar

Annual Meetings

TWELFTH NATIONAL CONFERENCE ON CITY PLANNING, 60 State St., Boston; Cincinnati, April 19-22.

NATIONAL FIRE PROTECTION ASSOCIATION, 87 Milk St., Boston; May 4-6; Chicago.

AMERICAN ASSOCIATION OF ENGINEERS; 63 E. Adams St., Chicago; May 10, 11, St. Louis, Mo.

AMERICAN WATER WORKS ASSOCIATION, New York City; Montreal, June 21-26.

AMERICAN SOCIETY FOR TESTING MATERIALS, Philadelphia; Asbury Park, N. J., June 22-25.

AMERICAN PUBLIC HEALTH ASSOCIATION, Boston; San Francisco, Aug. 30-Sept. 3.

The Vermont Society of Engineers held its eighth Annual Meeting, which was conducted as a joint meeting with the Aero Club of Vermont, at Hotel Vermont, Burlington, Mar. 10. At the close of the morning session, the following officers of the society were elected: President, J. W. Votey, dean of Engineering College, University of Vermont, Burlington; first vice-president, F. W. Denison, assistant engineer, Central Vermont R.R., St. Albans; second vice-president, G. R. Varnum, superintendent of quarries, Bontwell, Milne & Varnum Co., Barre; secretary, G. A. Reed, assistant state engineer, Montpelier; treasurer, T. W. Dix, professor of highway engineering, University of Vermont, Burlington.

The Engineering Institute of Canada's Toronto Branch has arranged, through its chairman, R. O. Wynne-Roberts, for the presentation of the following papers every Thursday evening during April and the first week of May, at the Engineers' Club, Toronto: Apr. 8—"Chemistry and Engineering," T. Linsay Crossley; Apr. 15—"Sarnia Intake," F. W. Thorold, "Reinforced Concrete Pipes," H. W. Heywood; Apr. 22—"Application of the Venturi Principles," E. Dean Wilks; Apr. 29—"Dredging," W. E. M. Bonn; May 6—"Ontario Highway Policy," W. A. McLean.

The American Association of Engineers, Chicago, announces the formation of the following new chapters: Newark (N. J.). Officers elected: President, Frederick A. Reimer, county engineer of Essex County; first vice-president, Robert A. Meeker, state highway engineer of New Jersey; second vice-president, Morris R. Sherrord, city engineer of Newark; third vice-president, David C. Boswell; fourth vice-president, Thos. J. Wasser, county engineer of Hudson County. Albany (N. Y.) Chapter. Officers elected: President, O. F. Rowland; secretary, R. N. Barrett; treasurer, R. E. Hartmann. Six vice-presidents were also elected. Bismarck (N. Dak.) Chapter. Officers elected: President, J. E. Kaulfuss, assistant chief engineer, North Dakota Highway Commission; vice-president, B. H. Long; secretary, G. F. Ludvigsen, assistant engineer, North Dakota Highway Commission; treasurer, W. T. Stratton, consulting engineer, North Dakota Railroad Commission. Trenton (N. J.) Chapter, officers elected: President, H. D. Robbins, division engineer, State Highway Department; vice-president, G. R. Moore, assistant division engineer, State Highway Department; secretary, R. R. Pope, resident engineer, State Highway Department; treasurer, A. G. Nicolaysen, State Board of Taxes and Assessments.

Chapter charters have been granted by the association in Carson City, Nev.; New Haven, Conn.; Warren, Ariz.; Delaware College, Newark, Del.; Ogden, Utah; Atlanta, Ga.; Carnegie Institute of Technology; and club certificates to petitioners from Santa Fe, New Mex. and Utica, N. Y. The board of directors has also approved the amalgamation with the Michigan Engineering Society and constitution which, after adoption by the State, will provide for the establishment of the Michigan Engineering Society as a state assembly of the association. The plan of amalgamation with the North Carolina Society, which recently voted to enter the association, was also approved on a similar basis. The Swarthmore College Engineers Club has affiliated with the association as a student chapter. At present there are about thirty members. The officers are as follows: President, Edmund P. Smith; vice-president, Howard Jenkins; secretary and treasurer, Edmund E. Bartleson. The club was founded in 1914. The Ohio State Assembly of the A. A. E., composed of the eight chapters and two clubs of the association in that state, adopted a constitution in Columbus, Feb. 28. Officers were elected as follows: President, C. R. Rood, Toledo; first vice-president, J. E. Root, Akron; second vice-president, E. K. Ruth, Cincinnati; secretary-treasurer, W. L. Mattoon, Columbus. Newly elected officers for various other chapters follow: Philadelphia Chapter: President, Edmund J. Fitzmaurice, Ballinger & Perrott; first vice president, J. J. Crowe; second vice president, Jos. Chapin; third vice president, E. E. Keller; recording secretary, H. H. Cramer; treasurer, Jesse R. Henderson; executive secretary, H. F. Kuzen. Ogden (Utah) Chapter: President, W. F. Turner; vice-president, H. J. Craven; secretary, E. H. Kidder; assistant secretary, B. W. Matteson; treasurer, W. S. Craven. Lincoln (Neb.) Chapter: President, Geo. W. Bates; vice-president, R. E. Davis; secretary, Geo. K. Leonard; treasurer, H. H. Wheeler. South Dakota Chapter: President, Frank S. Peck, state highway engineer; secretary, C. J. Loomer, assistant highway engineer.

North Central Division, National Highway Traffic Association, will hold a meeting at Detroit, on Thursday evening, April 15. George W. Walters, deputy commissioner of the Detroit Police Department, will speak on "One-Way and Segregated Traffic Streets." The discussion will be opened by Glen Phillips, of the Detroit City Planning Commission. Horatio S. Earle, of Detroit, will deliver a paper entitled "Pavements Required for Economic Highway Transport," the discussion of which will be opened by Arthur H. Blanchard, professor in charge of highway engineering and highway transport, University of Michigan.

PERSONAL NOTES

MAJOR-GENERAL WILLIAM C. GORGAS, former Surgeon-General of the U. S. Army and chief sanitary officer of the Panama Canal Zone, has accepted a five-year contract with the Peruvian Government to direct an extensive sanitation program there. He was scheduled to sail from Peru on April 1 for New York, Belgium and West Africa, and to return to that country the beginning of next year. During his absence his assistant, Colonel Wrightson, will be in charge of the new work.

ALFRED MULLIKIN, formerly first lieutenant, Sanitary Corps, in command of the 82nd Sanitary Squad, 86th Division, A.E.F., has been appointed assistant sanitary engineer, New York State Department of Health.

EDWARD D. VERY, formerly engineer, New York City Street Cleaning Department, and more recently engaged in consulting engineering work, has been provisionally appointed first assistant engineer, Bureau of Street Cleaning, Philadelphia, succeeding Dudley T. Corning, resigned.

WILLIAM COLLINS, formerly assistant consulting engineer of Decatur, Ill., has been appointed city engineer.

JAMES A. TONER, formerly assistant city engineer of Meriden, Conn., has been appointed superintendent of public works.

MAJOR-GENERAL W. L. SIBERT, formerly a member of the Isthmian Canal Commission and division engineer of the Atlantic division, and recently in command of Camp Gordon, Georgia, has retired from the Army. He has announced his intention to engage in engineering work.

J. H. KNOWLES has resigned as chief engineer of the Western Pacific R.R., headquarters San Francisco, to enter private practice. Mr. Knowles served the Western Pacific for ten years.

C. S. HEIDEL, state hydrographer of Montana, has been appointed state engineer, succeeding A. M. Mahon, who recently resigned to go into private business.

GEORGE M. SHEPARD has become associated with Louis P. Wolff, consulting engineer, St. Paul, Minn., in the practice of municipal and sanitary engineering. Previous to discharge from the Army, in January, 1919, Mr. Shepard was captain of Engineers on duty with the 3rd U. S. Engineers at Schofield Barracks, Hawaii.

ALBERT GIVAN has been appointed assistant state engineer of California. He was formerly city engineer of Sacramento, and for the past few years has been engaged in private engineering practice in that city.

E. P. PALMER, formerly resident engineer of the Rapid Transit Subway Construction Co., has become associated with Warren, Moore & Co., New York City, as engineer directing the company's contracts in the New York territory. As captain of Engineers he served in France in Transportation Department, A. E. F.

CHARLES E. DENNY, who, under Government control, was assistant Federal manager of the New York, Chicago & St. Louis R.R., has been appointed vice-president and general manager, with headquarters at Cleveland.

E. W. HAMMOND, acting engineer of maintenance-of-way, Buffalo, Rochester & Pittsburgh R.R., has been appointed engineer of maintenance-of-way, with headquarters at Rochester, N. Y.

F. S. SCHWINN, engineer on the valuation committee, International & Great Northern R.R., at Houston, Tex., has been appointed chief engineer.

HARRY E. BARLOW, since 1902 assistant engineer of the Chicago, St. Paul, Minneapolis & Omaha R.R., has been promoted to the position of chief engineer, with headquarters at St. Paul.

WILLIAM H. HOYT, for the past fifteen years assistant chief engineer of the Duluth, Missabe & Northern R.R., has been appointed chief engineer, with headquarters at Duluth.

HAROLD KNIGHT, during Government control assistant superintendent of maintenance, Erie R.R., with headquarters at New York City, has been appointed regional engineer of the Ohio region, with office at Youngstown.

HERMAN RETTINGHOUSE, chief engineer of the Chicago, St. Paul, Minneapolis & Omaha R.R., has retired after thirty years in railroad service. Mr. Rettinghouse began his career as a rodman on construction work on the St. Paul extension of the Wisconsin Central in 1883. Soon afterward he took a position with the Milwaukee, Lake Shore & Western, serving, successively, as leveler, instrument man and assistant engineer in charge of location, construction and maintenonce. In 1893 he left that road to engage in general engineering practice at Ashland, Wis., where he served as city engineer for three years. Later he returned to the Milwaukee, Lake Shore & Western, now a part of the Chicago & North Western, as assistant engineer in charge of construction and maintenance, and in 1900 was made superintendent of bridges and buildings of the Ashland division. In 1905 he became division engineer of the Southern division of the Wisconsin Central, and resigned from that position, in 1907, to become division engineer in charge of maintenance of the Chicago & North Western. He was promoted, in 1912, to the position of superintendent of the Iowa & Minnesota division, and, in 1913, received his appointment as chief engineer of the Chicago, St. Paul, Minneapolis & Omaha.

T. A. SPRATT has been appointed temporary superintendent in charge of all roads taken over by the Ottawa Suburban Roads Commission.

A. M. WEST has resigned as city engineer of North Vancouver, B. C., to engage in private business.

DAVID HANNA has resigned as chief of surveys and drafting in the roadways department of Toronto, to become superintendent of water-works at Windsor, Ont.

M. J. BUTLER, formerly president of the Engineering Institute of Canada, and, until his recent retirement, managing director of Armstrong-Whitworth Co., Ltd., has been appointed a member of the Housing Commission of Oakville, Ont.

JOHN H. RYCKMAN, recently of the bridge engineering staff of the Toronto Works Department, is now designing engineer for the Department of Public Works, Chicago.

LAURENCE A. BALL, consulting engineer, has formed a partnership with Howard H. Snyder, under the firm name of Ball & Snyder, with offices in New York City. They will engage in general consulting engineering practice.

HENRY HARVIE has resigned as assistant to hydraulic engineer of design, Hydro-Electric Power Commission of Ontario, to become associated with the Canadian Ingersoll-Rand Co., Montreal, as hydraulic engineer.

PIERCE J. MCAULIFFE, formerly manager of ship construction for the Emergency Fleet Corporation, has established consulting engineering offices in New York City. Although he retains his connection with ship construction, Mr. McAuliffe is devoting his attention particularly to engineering and industrial problems in connection with the pumping of solid materials.

R. V. MEIKLE, engineer of the Turlock irrigation district, California, has been appointed chief engineer in charge of the construction of the $6,000,000 Don Pedro dam and power plant for the Turlock and Modesto districts. Percy F. Jones, engineer of the Modesto district, has been appointed assistant to Mr. Meikle.

C. J. PARKER, formerly of Watertown, N. Y., and for the past 18 years principal assistant engineer to the chief engineer of the New York Central R.R., with office in Grand Central Terminal, New York City, has been advanced to the position of chief fire protection engineer of the New York Central.

OBITUARY

FRANK L. FULLER, civil engineer of Boston, well known throughout a considerable part of New England, died recently. In addition to his engineering practice in Boston, Mr. Fuller was for a number of years chairman of the Water Board, Wellesley, Mass., his home town.

G. REID MUNRO, civil engineer of Peterboro, Ont., died from influenza, March 1. He had been in the employ of the William Hamilton Mfg. Co., Peterboro, for many years. Mr. Munro was a member of the Peterboro Branch, Engineering Institute of Canada.

HARRY OSBORNE, of Montreal, formerly works manager of the Angus shops, Canadian Pacific Ry., died March 17, at the age of 61 years. He was born in Kent, England, and came to Montreal forty years ago, entering the service of the Canadian Pacific Ry. shortly after the formation of the company and working his way up to the position of works manager, which he resigned about a year ago.

WILLIAM WATSON COE, general manager, Pocahontas Coal & Coke Co., Roanoke, Va., died at Charlestown, W. Va., March 31. He was formerly thief engineer of construction of the Shenandoah Valley R.R., and later chief engineer of the Norfolk & Western R.R. He was born at Winsted, Conn., in 1846.

JAMES HENRY DECKER, formerly connected with the construction of the Panama Canal, died at Lafayette, Ind., March 29. He was born at Watertown, N. Y., in 1882, and was a graduate of Purdue University.

FRANCIS W. THROOP was drowned at Chosica, near Lima, Peru, March 25. He was engaged in hydro-electric development work in the Andes Mountains for W. R. Grace & Co., New York City. Reports state that he was thrown by his horse into a mountain stream. He went to South America in 1918 for Grace & Co. Prior to that time he was for about twelve years superintendent of the Dominion Power & Transmission Co., at St. Catharines, Ont. Mr. Throop was born in Ontario County, N. Y., 52 years ago.

JOHN J. MILLER, retired contractor and builder of docks and bridges, died at his home in Brooklyn, Feb. 26, of paralysis, at seventy-seven years of age.

ORLANDO W. NORCROSS, president, Norcross Brothers Co., Worcester, Mass., died from heart failure, at eighty-one years of age, Feb. 27, at his home in that city. Among the important works carried out by Mr. Norcross were the remodeling of the White House, in 1902; the building of the New York Public Library; the construction, under exceptional difficulty, of the pneumatic caisson foundations for the new Boston Custom House, and the removal of the ledge in the channel at the Kittery Navy Yard.

DR. AUGUSTUS VALENTINE SALPH, consulting civil engineer, San Francisco, Cal., died at his home in Berkeley, from influenza, Feb. 13. He was born in San José, Cal., in 1871. He graduated from the College of Civil Engineering, University of California, in 1894; reutrned the next year and received the M.S. degree, and then continued his studies at Cornell University, graduating from there with degree of Ph.D. in 1897. The year following Mr. Salph returned to the University of California as instructor in drawing and civil engineering. Five years later he was placed in charge of the drafting room as structural engineer for the U. S. Reclamation Service at Hazen, Nev., on the Truckee-Carson project, having charge of the design of the wooden bridges, concrete structures and all other structures in connection with the project. In 1906 he became associated with John B. Leonard, consulting structural engineer, as engineer, on the design of steel and concrete bridges and buildings. Later he was assistant engineer for the City and County of San Francisco Department of Engineering and assistant state engineer in charge of the engineering work along the San Francisco waterfront under the Board of State Harbor Commissioners. Upon leaving the Harbor Commission, Mr. Saph became engineer of the Spring Valley Water Co., San Francisco, and had charge of the design of the water tower for the Calaveras Dam. In 1914 he began his private practice as consulting engineer, specializing on steel and concrete.

WILLIAM E. WOODS, accounting engineer for the past fifteen years of the Atlanta & West Point R.R., died at his home in Atlanta, Ga., March 13. He was born in Philadelphia and was educated at the U. S. Military Academy, West Point. In 1905 he went to Atlanta as engineer in charge of the construction of the Atlanta & Carolina Ry., which project was abandoned. Soon afterwards he entered the service of the Atlanta & West Point. He was also engineer in charge of the construction of the Produce Row Bldg., Atlanta, and the Georgia railroad yards. Mr. Woods was 59 years old.

BUSINESS NOTES

THE SOUTHWESTERN ENGINEERING CO., Hutchinson, Kan., has opened a branch office at Fort Worth, Tex., with Harvey R. Rankin in charge.

THE CLARKSBURG (W. VA.) ENGINEERING CO., whose offices in that city have been closed during the past year on account of the absence in Government service of W. S. Baver and C. P. Collins, has reopened under the firm name of the Clarksburg Engineering Co., Inc. Mr. Collins will assume the duties of manager.

BALDWIN & WELCOMER, general contractors, handling building construction, industrial and utilities work, who have maintained offices at Jersey City, N. J., Union City, Pa., and Niles, Ohio, have opened an office at Warren, Ohio, in the Western Reserve Bank Bldg., which will be the main office for their work in the Mahoning Valley.

JOHN F. REAGAN, JR., has been appointed Eastern sales manager, Neptune Meter Co., New York, to succeed the late Daniel B. McCarthy. Mr. Reagan has been with the Neptune Co. for nearly ten years, representing them as a salesman in several Eastern states. Prior to his connection with the company, he was general manager of the Consolidated Water Co., Utica, N. Y.

G. E. WARREN has resigned as assistant manager, service bureau, Universal Portland Cement Co., Chicago, to continue his duties as manager, American Concrete Pipe Association. Mr. Warren has been with the Universal Co.'s service bureau for five years, the last year acting also as secretary-treasurer, American Concrete Pipe Association. The association has recently been reorganized and will have an office in Chicago. J. W. Lowell, eastern manager, Universal service bureau, will assume the duties of assistant manager of that department at Chicago.

THE HOLT MANUFACTURING CO., Inc., Peoria, Ill., has been holding a series of schools in order to educate prospective buyers, distributors and users of caterpillar tractors in the fine points of the care, operation, and maintenance of these machines. Under the leadership of F. L. Peterson, service engineer, schools have been held in Lincoln, Neb.; Fargo, N. D.; Atlanta, Ga.; and Richmond, Va.

MACE MOULTON, JR., for six years New England sales manager of the United States Asphalt Refining Co., New York and Baltimore, has formed the firm of Mace Moulton, Jr., Inc., to handle the sale of bituminous road materials and pavement. The company offices are at 6 Beacon St., Boston.

THE CONRADSON MACHINE TOOL CO., has been incorporated at Green Bay, Wis., and will be associated with Joseph T. Ryerson & Son, Chicago, who will handle the sales of the output of the new plant. C. M. Conradson is president of the new concern.

THE BUSH, ROBERTS & SCHAEFER CO., has been organized with offices at 1 Madison Ave., New York and McCormick Bldg., Chicago, by the directors of the Roberts & Schaefer Co., Chicago, and Colonel Lincoln Bush, formerly chief engineer of the D., L. & W. R.R. The company will act as engineers and contractors for reinforced concrete bridges and viaducts, track elevation work, piers, docks, terminal facilities and general engineering and construction work. The Roberts & Schaefer Co. will continue its present lines of engineering construction.

D. H. BRILLHART and G. R. BROTHERS, formerly manager of the fabrication department, and of the sales department, respectively, of the Bethlehem Fabricators Co., Inc., have incorporated the firm of Brillhart-Brothers Co., Inc., to engage in a general contracting and engineering business. The company headquarters will be in Bethlehem, Pa.

THE HYDRAULIC PRESSED STEEL CO. announces the consolidation of all of its interests under the name of the Hydraulic Steel Co. of Cleveland.

THE JOHN F. BYERS MACHINE CO., Ravenna, O., announces the opening of its new Chicago district office, 20 West Jackson Boulevard, in charge of E. L. Kelzer.

GEORGE C. KAUCHER, of the contracting firm of Kaucher & Hodges, Memphis, was recently elected president of the Memphis Builders' Exchange.

O. A. OLSTAD, formerly of the New York office of Blaw-Knox Co., has been made manager of the New England territory, with office in the Little Bldg., Boston. He succeeds A. W. Ransome, recently appointed manager of the Pacific coast territory, with office at 754 Monadnock Bldg., San Francisco.

T. L. LAWRY has been appointed manager of the steel buildings division of the Liberty Steel Products Co., Inc., Pittsburgh. Mr. Lawry was formerly manager of the Pittsburgh district of the company. In addition to handling the steel building division, he will act as manager of the industrial department of the Chicago district.